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CONTENTS

1. **Management**—Gas industry progress, business problems, statistics, government regulation, safety, personnel, education.....281

2. **Energy Supply and Economics**—Resources, reserves, and competitive applications of the fossil fuels and other sources of energy, including nuclear and solar energy.....285

3. **Natural Gas and Petroleum Production**—Geology, exploration, drilling, well management, reservoir engineering.....288

4. **Gas Conditioning and LPG Recovery**—Condensate, dust, CO_2 and sulfur removal, dehydration, odorization, oil fogging, humidification; LPG recovery and refining.....291

5. **Natural Gas Transmission**—Pipelines, compressors, dispatching, flow regulation, communications, maintenance.....292

6. **Gas and LPG Storage**—Holders, pressure tanks, underground storage; liquefaction, refrigerated storage.....294

7. **Manufactured Gas and Chemical Processing**—Gasification of coal, oil; reformed gas; chemical treatment; byproducts; synthesis gas production and conversion; petrochemicals; catalysts, catalyst development.....295

8. **Gas Distribution**—City utility systems: design, operation, maintenance; weather influence on peak loads and supply; LPG-air mixtures.....298

9. **Gas Fuel Utilization and Appliances**—Domestic, commercial, industrial; burners; combustion research; air pollution.....300

10. **Equipment and Instrumentation**—Production and handling equipment, and maintenance; computers; controls; measurement.....303

11. **Materials of Construction, and Corrosion**—Metals, refractories, plastics; corrosion measurement, prevention.....305

12. **Analytical Methods and Tests**—Standard and research techniques for gas-making materials, products, processes; instrumental analysis.....307

13. **Basic Science**—Chemistry, physics and basic engineering related to gas technology; physical properties of gases: phase equilibria, thermodynamics, reaction kinetics, heat and mass transfer, fluid flow.....309

Services Available to Readers—Photocopies, microfilm, Russian translations, bibliographies and literature searches, *Gas Abstracts on Cards*, back numbers of *Gas Abstracts*.....**Inside Back Cover**

Publications Abstracted for Gas Abstracts.....**Back Cover**

O. P. BRYSCH, Editor

P. J. CHATTA, Assistant Editor

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1. MANAGEMENT

Gas Industry Expansion

Record Seen for Industry's 1959 Expansion Costs. *A.G.A. Monthly 41,* 2 (1959) Sept. (2 pp.)

A.G.A. Bureau of Statistics estimates that the nation's gas utilities and pipeline companies will spend a record $1,859 million for construction this year. If true, expenditures will be 4.9% higher than the industry's all-time peak of $1,772 million set in 1957. This also will exceed 1958's outlays of $1,618 million by 14.9%. Bureau says that reports from individual companies indicate that outlays for plant and facilities expansion will continue to rise steadily to $2,166 million in 1962. Construction during 1959-62 is expected to cost $7.9 billion according to current A.G.A. forecasts. This will represent a 25.7% increase over the $6.3 billion spent in the previous four-year period.

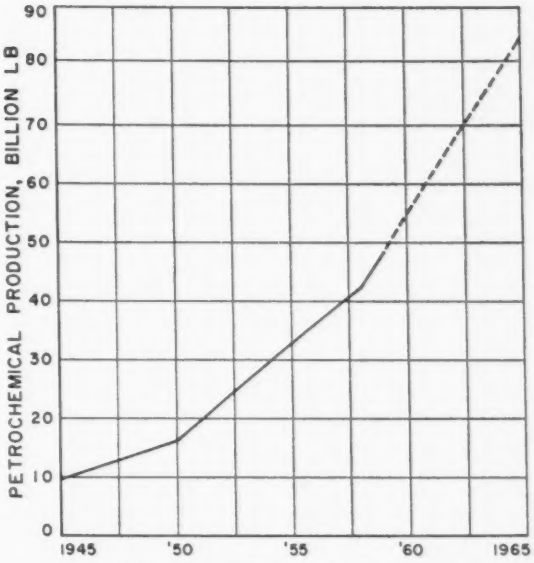
Northwest Gas Out of Toddler Stage. D. H. Stormont. *Oil Gas J. 57,* 27 (1959) Aug. 31 (3 pp.)

From its standing start three years ago, natural gas has climbed to the position of a full-fledged fuel in the U.S. Pacific Northwest region. During 1958, Pacific Northwest Pipeline Co. shipped an average of 593,000 MCF/day into western Colorado, Idaho, Oregon, Utah, Washington and Wyoming. Of this volume, 300,000 MCF was received from Westcoast Transmission Co. at the Canadian border. Actually only 210,000 MCF of Canadian gas was purchased by Pacific Northwest. The remaining 90,000 MCF was taken by El Paso Natural Gas Co., Pacific Northwest's parent, on an exchange basis for gas delivered at the southern end of the line.

Developing and Installing a Construction Analysis System. J. L. McCollum. *Gas 35,* 62 (1959) Sept. (5 pp.)

Article presents Southern Counties Gas Co.'s (Los Angeles) attack on problems of mushrooming growth and rising prices. Consultant firm was hired to study company's practices and provide a nucleus around which a planning program could be developed. Report revealed that best opportunity for controlling construction and operating costs lay in the planning, scheduling and dispatching of distribution construction work. Using material from past method studies, the report also provided standards that could be used for making time estimates. Company took its own objectives and followed the consultant's recommended area of attention and developed an initial program around a four-step process: 1) Planning, 2) scheduling, 3) dispatching and 4) summarizing.

U.S. Petrochemical Production Rate 1945-65



(Data from *U.S. Petrochemicals Reach. . .* See Abstract, p. 282.)

Petroleum

Canada Pushes "Hard Sell" Plan. *Petrol. Week 9,* 11 (1959) Sept. 4 (2 pp.)

Royal Commission on Energy says crude output must be hiked by 200,000 bbl/day within 18 months to assure vigorous growth. Commission report, two years in the drafting, outlined a "hard sell" program for Canadian crude, with particular emphasis on U.S. markets which they described as the only presently attainable export market for Canadian crude because of high exploration costs and landlocked wells. Commission feels that the recent exemption from U.S. import controls of crude, unfinished oil and finished products from Canada represented a substantial change in the attitude of the American government toward Canadian oil.

Petrochemicals

Coming: A New Step-Up in Petrochemical Capacity. *Petrol. Week 9,* 40 (1959) Aug. 14 (13 pp.)

Demand for petrochemical products of every conceivable type has increased steadily and continues to rise. This demand is felt throughout the world. In 1958, the synthetic organic chemical industry, of which petrochemicals represent the major component, sold, in the U.S. alone, a total of $5.4-billion worth of products. A comparatively small percentage was exported. Since the end of World War II, construction of new petrochemical facilities has proceeded by steps. The country has witnessed a cyclic

trend of intense expansion every five years. Article discusses petrochemicals' expansion into broader fields and predicts consumption outside of the U.S. in the next five years.

U.S. Petrochemicals Reach New Peak. R. L. Bateman. *Oil Gas J. 57,* 121 (1959) Sept. 7 (2 pp.)

Preliminary estimates for 1959 point to another all-time high for petrochemicals—48.8 billion lb, an increase of 15.5% in 1958. Upsurge in the overall economy, which began in mid-1958, is apparent in the production figures for the entire chemical industry. These will show a gain of 14.5% for 1959 over 1958 (174 billion lb vs 152 billion). Since the strong demand is benefiting all segments of the chemical industry, the petrochemical share of the total remains the same as in 1958—28%. By 1965, the demand for petrochemicals will grow to 85 billion lb, with value in excess of $10 billion. Present product uses will expand; there will be entirely new resins, fibers, synthetic fuels and lubricants.

Europe's Petrochemical Growth. H. A. Kirsch and W. E. Kuhn. *Oil Gas J. 57,* 123 (1959) Sept. 7 (3 pp.)

Vitality of the European petrochemical industry is evidenced by the growth in total investments. In terms of U.S. dollars, the petrochemical industry in the five European countries most active in this area (France, West Germany, Italy, the Netherlands, Great Britain) has grown from an estimated $240 million in July, 1953, to about $549 million by December 1957. Planned expansions in facilities are expected to increase this figure to about $1.2 billion by the end of 1960. In terms of carbon content, petrochemical growth in these same five countries has grown from about 208,000 metric tons in 1953 to approximately 630,000 metric tons in 1957. By the end of 1960 this figure is expected to reach 2 million metric tons. Major areas included in this expansion are synthetic rubber, polyethylene, ethylene oxide and derivatives, polypropylene, and raw materials for plastics and solvents. This contemplated expansion in petrochemical production will result in heavy demands for petroleum and natural gas-derived raw materials.

World Is Building Petrochem Plants at Fast Clip. *Oil Gas J. 57,* 126 (1959) Sept. 7 (22 pp.)

More than 150 projects are planned or underway. U.S. still is the No. 1 petrochemical producer, but big projects in Europe, Australia, Japan and Argentina will hike capacity abroad. Emphasis is on new polyethylene and polypropylene plants. Article includes world-wide table showing existing as well as proposed plants in the U.S., Canada and the rest of the world. Because of the large number of plants and projects in the U.S., this portion of the table is divided into organics, nitrogen chemicals, butadiene and copolymer, sulfur conversion and carbon black.

Ethylene

A Look at Ethylene Glycol Today. P. W. Sherwood. *Oil Gas J. 57,* 85 (1959) Aug. 24 (6 pp.)

Output of ethylene glycol has doubled since 1951 when 597 million pounds were produced. Estimated U.S. production of ethylene glycol in 1958 was nearly 1.2 billion pounds. Of this total, approximately 120 million pounds was produced from formaldehyde plus carbon monoxide. The remaining 90% of ethylene glycol output was obtained by the hydration of ethylene oxide.

LPG

LPG Industry Facing Some Big Changes. W. A. Bachman. *Oil Gas J. 57,* 48 (1959) Aug. 24 (3 pp.)

Despite signs of prosperity, within the next five years LPG industry will face a market upheaval from 1) a shortage of butane and 2) an oversupply of propane. First factor will arise from an approaching jump in demand for butane from refiners who need it to make isobutane for their alkylation units. This probably will take butane completely off the retail market and create an outright shortage. Propane will be in oversupply because it is expected to be a byproduct of the stepped-up butane production. The net result, according to men who buy and sell LPG, is this: A new push for greater supplies of butane and a coordinated drive to find new markets for propane.

First Barge Shipments of LP-Gas to Alaska Set for October. *Gas Ind. 3,* 10 (1959) Sept.

Petrolane Gas Service, Inc., has launched into a transportation program that will deliver large quantities of bulk fuel to Alaska at greatly reduced prices. Instead of the restrictive price of $.65 and $.70/gal, fuel prices for the consumer are sure to be much lower. Fuel uses will find broader application as a result. Petrolane's cost-lowering plans begin with a long-term contract with the General Petroleum Corp. which can furnish in excess of one million gallons a month from its Ferndale, Wash., refinery. Additional sources in the area will be available as more LPG is needed. Although one barge (equipped with four 30,000-gal tanks, and making about two round trips a month) can supply Alaska's present needs, it is expected that the market will reach between 1 and 1½ million gal/month within the next 18 months. To supply this market Petrolane plans to have at least three barges in regular operation between Ferndale and Seward.

Florida Challenge

Atlantic Coast Spot Report: LPG Will Remain No. 1 with Dealership Growing into Natural Gas Utility. E. G. Dickson. *Butane-Propane News 21,* 37 (1959) Sept. (5 pp.)

Ten years ago, an ambitious franchised propane-pipeline system started in Hialeah, Fla., as City Gas Co. Today, that same pipeline system, now grown to 500 miles, has become the key in a consolidation and expansion program by which City Gas: 1) Created one of the largest LPG distribution systems in the nation by bringing together five LPG companies with a combined annual load of 20 million gal/year; 2) will meet the natural gas invasion by going into the natural gas business, starting with its propane pipeline, and 3) laid the groundwork for continued expansion of LPG sales (to a projected 30 million gal by 1962-3 through strategic use of the capabilities of both natural and LPG, so they will complement and stimulate each other. City Gas Co. will divide Greater Miami with two other natural gas distributors. Until its first delivery of natural gas (scheduled for next spring), it will continue to distribute to pipeline customers undiluted propane vapors at prices competitive to natural gas.

Florida Report. Part 1. What Is the Situation Today? W. W. Clark. *Butane-Propane News 21,* 29 (1959) Sept. (3 pp.); **Part 2. How Does the Future Look to LPG Dealers?** *Ibid.,* 32 (1959) Sept. (5 pp.)

Natural gas entered Florida in June. The LPG industry has enjoyed something of a honeymoon, often ignoring big potential loads. For example, an authoritative rundown of the Florida potential in carburetion and just two of the many other non-domestic uses indicates that: 1) In 1958, approximately 33,500 tractors were operating in the state. Only about 8% used LPG, but they consumed 2 million gal. Potential is 30 million gal/year or more. 2) There is a potential load of about 20 million gal/year for operating drainage and irrigation pumps. 3) Potential for weed burning is 33 million gal/year. With a saturation of less than one-third, LPG dealers could pick up 12 million gal/year in sales, or more. If Florida dealers could sell these three loads up to their potential, they could increase annual sales by more than 60 million gal, or more than one-third of their estimated 1958 total sales, 160 million gal. Nine out of ten dealers expect to lose part of their load, but they anticipate that they will be able to make it up in two years and that natural gas will eventually benefit them. During transition period summer loads will be built fast and an all-out effort will be made to build non-domestic loads of the type that add up to good volume in a hurry.

Gulf Coast Spot Report: Dealer Rides Natural Gas Publicity Wave to Boost Heating Sales. H. J. Miller. *Butane-Propane News 21,* 43 (1959) Sept. (3 pp.)

Bradenton, Fla., dealer has already boosted annual output 100,000 gal through an aggressive program pushing central heating and air conditioning systems in suburban and rural areas. While local residents are attracted by glamor aspects of natural gas, the line and its laterals may not reach rural areas for years—if ever. With this in mind, an aggressive advertising program pushing heating equipment was launched. Service program was emphasized and to residents of Florida's mushrooming housing developments went the message that it is better to have your own gas well in your own backyard.

Gas Challenge Stirs Florida Oil Men. *Petrol. Week 9,* 52 (1959) Sept. 11 (2 pp.)

Oil men in Florida are generally confident about their defense against gas. According to one source, only 5% of the residential market has fallen to gas. Nevertheless, competition from gas is strong and is getting stronger. Florida oil men have enlisted promotion aid from an unusual source—the electric utilities in a fight to retain the almost complete control they have enjoyed over a market that consumes more than 50 million bbl/yr of fuel oil.

Offshore Operations

Economics of Offshore Petroleum Development in the United States. B. Dykstra. *Gas Age 124,* 34 (1959) Aug. 20 (6 pp.)

At the beginning of 1958, estimated proven offshore reserves were one billion barrels of oil and six trillion cubic feet of gas. It is estimated that ultimate recoveries on the shelf of Texas and Louisiana within reach of present drilling and production methods might be 8½ billion barrels of oil and 64 trillion cubic feet of gas. Wage scale for an offshore oil worker is $3.42/hr. This basic labor cost sets the measure for all costs. A well in 65 ft of water 10,000-11,000 ft deep will cost $750,000, and wells costing $1 million are no exception. However, a well 10,000-11,000 ft deep under present rules of proration is allowed to produce only 173 bbl/day. This and other economic factors have caused a slowdown of offshore operations to such an extent that equipment is idle and skilled labor is leaving the area. Slowdown of activities has particularly affected the contractors who have contributed immeasurably to the solution of technological problems. To reverse the downward trend of operations it will be necessary to lighten the increasing governmental burden and to set higher allowables for offshore wells in deeper water.

Automation

Systems Engineering. T. J. Williams. *Oil Gas J. 57,* 93 (1959) Aug. 10 (5 pp.)

Author predicts that the next decade will see solution of most of the problems relating to systems engineering and computer application. The industry then will be engaged in what may be termed "economic automation"—i.e., as much instrumentation and automatic control (including computer control) as can be economically justified, not automation just for the glamor of it. It is expected that a minimum of up to 75 of the 100 largest companies will have groups studying process control within this period. It seems an absolute necessity that each of them will have access to analog-computing equipment to carry out studies.

Information

Gas Handbook Issue. *Amer. Gas J. 186,* 21 (1959) Aug. 15 (entire issue.)

Eight major categories comprise annual handbook edition: Design, construction and materials; regulation and measurement; corrosion; odorization; properties of gases; peak shaving and LPG data; utilization and general data.

Education

Operator Training in New Plant Startup. P. W. Pontius, P. A. van Tassel and J. H. Field. *Chem. Eng. Progress 55,* 38 (1959) Aug. (4 pp.)

Proper training of chemical operators is becoming increasingly important in the startup of new plants. Article describes program used at the Institute, W. Va., and Seadrift, Texas, plants of Union Carbide Chemicals. Program includes basic training of new employees and specific job training of both new and experienced personnel. Safe, efficient operation with a minimum of errors during startup is the primary objective. The development of a strong, flexible permanent operating organization can be the long range benefit.

Customer Service

A Guide to Training Servicemen. Part 5. Gas Incinerators . . . and People. R. W. Bell. *Gas 35,* 67 (1959) Sept. (3 pp.)

Gas incinerators, because they are relatively new, have received scant attention. At one time incinerators were considered luxury appliances, but with sales departments realizing the importance of the load from this appliance and with increasing concern about air pollution, gas incinerator is fast finding its place in many homes. Those in the service field are fortunate that it is not necessary to develop an entire training program for the successful servicing of gas-fired incinerators. In reality, if a company's training course on all other appliances has been successful, its men will be ready to service gas incinerators with a minimum amount of additional training. Additional training should merely place special emphasis on certain subjects. Article includes outlines of the general training program and the incinerator program used by the Metropolitan Utilities District (Omaha, Neb.)

Promotion

Gas Heat Promotion Is Big Figures. *Fueloil & Oil Heat 18,* 79 (1959) Sept. (3 pp.)

Outline of data collected from officials of local oil-heating groups in about two dozen U.S. areas is published. Areas selected are those where the National Fueloil Council advertising campaigns are now in progress. Facts and figures on gas promotion are given for Boston and Springfield, Mass.; Providence, R.I.; Hartford, Danbury and Bridgeport, Conn.; New York City, Kingston and Rochester, N.Y.; Philadelphia and Harrisburgh, Pa.; Baltimore, Md.; Washington, D.C.; Smithfield, N.C.; Charlotte, Greenville and Spartanburg, S.C.; Detroit, Mich.; Duluth, Minn.; Fort Wayne and Indianapolis, Ind., and St. Louis, Mo.

Oil Heat Promotion and Your Future. C. M. Blickensderfer. *Fueloil & Oil Heat 18,* 74 (1959) Sept. (2 pp.)

API Fuel Oil Committee is progressing rapidly in two projects—a research plan and a study of ways and means to combine into one organization all of the activities of the National Fuel Oil Council, Oil Heat Institute, API Research Program and any others that exist. At the same time, activities of the National Fueloil Council, Inc., are being expanded. Objectives of this association are to organize and financially assist cooperative advertising promotion at the local level and to disseminate to the public useful information about oil heating in a manner which will improve the stature of the industry and increase public acceptance. Strong local organization support for oil heat promotion will go far to continue growth and profits from fuel over the next decade.

Safety

The CATC Fire . . . How It Happened and What Followed. *Oil Gas J. 57,* 94 (1959) Aug. 3 (3 pp.)

At about 1545 CST on October 15, 1958, a fire occurred on the offshore Platform 45-E of the West Delta Block, Gulf of Mexico, with a resultant loss of life of one known dead and six missing, presumed dead. Property damage, exclusive of loss to petroleum products and costs of extinguishing the fire, is estimated at 6 million dollars. These words introduce an official U.S. Coast Guard report on the now-famous oil disaster. In the interest of preventing recurrences of such accidents, the article contains an account based on the Coast Guard report on what caused the disaster, what followed it and what the consequences to offshore operators likely will be.

Breath of Life for Asphyxiated Refinery Employee. W. E. Doering. *Petrol. Eng. 31,* C-17 (1959) Aug. (2 pp.)

With the large number of potential causes of asphyxiation present in today's refinery, those responsible for plant safety must know when and how to administer oxygen and train personnel in the use of resuscitation equipment. The importance of immediate oxygen administration in saving the life of an employee near death from acute asphyxia is generally recognized throughout all industry by safety and medical directors. This vital emergency measure can be easily provided by a refinery that has on hand: 1) Easy-to-use accessible resuscitator, in top working order and with an adequate oxygen supply, and 2) employees in the vicinity familiar with the equipment.

Gaseous Oxygen Fires and Explosions. A. E. Miller. *Nat. Fire Protect. Assoc. Quarterly 53,* 33 (1959) July (8 pp.)

Article cautions that personnel must be taught that although oxygen is technically a noninflammable gas it must be handled and treated just as cautiously and with as much respect as an explosive. Article is limited to discussion of gaseous oxygen.

Maintenance

Anticipating Maintenance Problems in New Plant Startup. T. W. Tomkowit. *Chem. Eng. Progress 65,* 44 (1959) Aug. (3 pp.)

In planning a maintenance program for the startup of a new plant, one cannot adopt a conventional approach. Serious consideration must be given to such variables as the personnel available, the type of plant to be operated, its location, complexity, etc. While the program discussed in the article was specifically developed for the startup of a new plant, any or all of the principles can be applied toward improving the maintenance effectiveness of an existing organization. The program was developed for a complex, continuous plant of refinery-type construction, novel to the plant site, posing many safety problems and to be manned by short-service maintenance mechanics. Principal objectives of this program were a safe, economical startup and the development of a self-perpetuating maintenance improvement program.

Cost Accounting

Bibliography of Investment and Operating Costs for Chemical and Petroleum Plants, January-December 1957. S. Katell, J. H. Faber and B. L. Maddox. *U.S. Bur. Mines Inf. Circ. 7884,* (Washington: U.S. Govt. Printing Office, 1959, 57 pp.) $.40.

Present report is concerned with the period designated in the title and presents abstracts of cost data obtained from twelve sources. Although most items are related to chemical and petroleum plants, a few pertain to related fields such as markets, drilling costs for petroleum and field prices of crude oil. Certain articles discuss various aspects of cost-estimating procedures or description of processes. Cost bibliographies prepared by other groups are discussed. The two references can be considered as supplemental to this report since the amount of overlap in the contents is insignificant.

2. ENERGY SUPPLY AND ECONOMICS

Gas Reserves

Will We Find Natural Gas Near Northeast Markets? J. E. Johnston, J. Trumbull and G. P. Eaton. *Gas Age 124,* 25 (1959) Aug. 20 (5 pp.)

Seismic and magnetic surveys indicate that the basement is deeper and more irregular than previously supposed and that a basement ridge may separate the shelf sediments into two major elongate basins parallel to the shelf edge, thus forming possible entrapping structures and possibly restricted depositional basins. Lower Paleozoic clastic rocks found in the subsurface of Georgia and Florida, and which may occur elsewhere in downfaulted basins, could be source beds and reservoir rocks of oil and gas over wide areas. Lower Cretaceous, Upper Jurassic and Triassic sedimentary rocks recognized in some wells must wedge out updip, and numerous unconformities probably occur. The marine sediments were presumably deposited in or close to shelf areas that possibly contain reefs and are partially bordered by known granite washes; thus both source and reservoir rocks are probably present.

Panhandle Operators Reap a Second Crop. F. J. Gardner. *Oil Gas J. 57,* 255 (1959) Sept. 7.

Operators in the Panhandle region of Kansas and Oklahoma have discovered another good pay zone in the Permian section there. Thirty years after the discovery of the Hugoton gas field, and only a few hundred feet deeper than the Sumner and Chase groups, a second major gas reservoir has captured widespread attention. It's the Council Grove group immediately underlying the Chase. At least ten new pools have been discovered in the past few months. Most important significance is that an entirely new blanket of gas is being unfolded all over the Hugoton embayment and at depths above 4000 ft.

Canadian Field and Reservoir Data. Canadian Gas-Field Data. S. Brodylo. *Oil Gas J. 57,* 165 (1959) Aug. 17 (11 pp.)

Statistical summary of all Western Canada's oil and gas fields.

Energy Sources

The Heating Market and the Situation of the Competing Forms of Energy. L. Segelken. *Gas- und Wasserfach 100,* 777 (1959) July 31 (12 pp. German text.)

Study of joint items of the energy balance of the Federal German Republic for 1957 shows that these are divided into 60% for heating, 30% for power and 10% for chemical energy. The most significant of these, the heat market, is classified into heavy and intermediate industries, and it is shown that the breakdown of heating oils in the German energy market places them in the intermediate industry group. This also is the principal receiving area for gas and coke, and here the gas industry is more strongly concerned with the great availability of oil than with the electric industry because of competition in the power market. A general broad development is proposed to create, in the interests of the user, an energy economy which is characterized by availability of many energy forms.

World Completions and Footage. *World Oil 149,* 99 (1959) Aug. 15 (2 pp.)

Free World drilling activity forecast indicates a comeback in 1959, after a two-year downward trend. It is predicted that the ten major oil producing areas outside the Iron Curtain will complete 57,936 wells, up 2% over 1958. However, the total still will be 7.8% less than 1957 and 13.5% less than the 66,981 wells completed in 1956, the most active drilling year in oil industry history.

World Crude Production. *World Oil 149,* 101 (1959) July (2 pp.)

During 1958, U.S. operators, accounting for 37.3% of the world total, produced 6.7 million bbl/day of crude, for a substantial decrease of 460,450 bbl/day, or 6.4% from the 1957 average. This was the first drop in U.S. crude production in five years. Areas outside the U.S. produced 11.3 million bbl/day of crude, an increase of 567,204 bbl/day, or 5.3% over 1957. Result: World total barely edged up to a new record average of slightly less than 18 million bbl/day—106,754 bbl/day, or 0.6% more than the 1957 average.

Petroleum Reserves

Oil in Australasia: Report on Petroleum Prospects in 17 Nations. *Oil Gas J. 57,* 114 (1959) Aug. 31 (3 pp.)

Oil provinces in Australasia are comprised of varying categories from brilliantly promising grading downwards to the downright discouraging. One thing is certain—not a single area can be written off the books without more exploration or a greater density of drilling. Exploration and drilling activity generally should increase over previous years. Brief review on activities in Afghanistan, India, Thailand, West and East Pakistan, Burma, Laos, Cambodia, Philippines, Formosa, Japan, Sumatra, Indonesian and British Borneo, New Guinea, Australia, and New Zealand.

Underground Nuclear Explosions: Awesome Recovery Promise. C. C. Anderson. *Petrol. Eng. 31,* B-28 (1959) Aug. (4 pp.)

For several years, atomic energy has been at work for the petroleum industry in several applications. Neutron logging, gamma ray logging and the use of radioactive markers and tracers are a few of the jobs done by the atom. More recently, radioactive energy has been put to work measuring and indicating the weight of drilling fluids and slurries. One day drilling men will harness nuclear forces for rock destruction in drilling holes deep into the earth. Nuclear reactors will supply heat to petroleum reservoirs for tremendously improved recoveries from "depleted" formations, tar sands and oil shale. Reactors also will generate great power to drive equipment in all phases of the industry. Even more exciting is the prospect of the tremendous confined forces of an underground nuclear explosion. Discussion of the government's "Operation Plowshare" program.

Competitive Energy

Gas vs Electricity in Heating-Load Battle. L. A. Brand. *LP-Gas 29,* 35 (1959) Sept. (4 pp.)

Recently the electric industry has increased its efforts to build up new markets and one of its prime targets has been the gas industry—both LP and natural. Author reports on some of the measures that must be taken if one of the most important markets—the heating load—is to be retained.

Ulcers, but Good Bank Balances. R. Gray. *Fueloil & Oil Heat 18,* 61 (1959) Sept. (10 pp.)

Accurate profile of retail fuel oil business, based on data supplied by a group of distributors, indicates that during the past heating season, fuel oil industry experienced a new high in volume and profits. Competitive fuels have slowed but not stopped the growth rate. Consumer opinion polls indicate that the general public has a high regard of oil heat. Major drawback is lack of low cost equipment for the speculative new home market. Outlook, however, in over-all industry is for fair to good profits with even a modest expansion.

Heat Pump

Many Ways to Use Heat Pump Cycle. E. R. Ambrose. *Heating, Piping and Air Conditioning 31,* 90 (1959) Aug. (4 pp.)

Author describes various heat pump operating cycles and weighs the merits and possibilities of this

type of system, citing installation and operating cost figures from existing installations to support his opinions.

Drilling

Improvements in Directional Drilling Technology Reduce Footage Costs. L. H. Galeener. *World Petrol. 30,* 50 (1959) Aug. (4 pp.)

Inherent advantages of the modern-day science of controlled directional drilling are quite obvious when considered in the light of simple efficiency. A lesser publicized fact is that this technology has caused impressive reductions to be realized in drilling costs. Statistics indicate that in the last 25 years, such cost-determining factors as labor, materials and equipment have increased some 60%. However, the true picture only emerges when it is considered that 1959 total footage figures are 95% over those of two and one-half decades ago. Also, the inflationary trend must be considered. Therefore, when drilling costs are measured in terms of constant dollars/foot drilled, reductions in drilling costs are truly an achievement of real dimension.

Operation Mohole. W. Bascom. *Petrol. Eng. 31,* B-24 (1959) Aug. (4 pp.)

First full-scale drilling project designed specifically to probe the little-known and indefinite boundary between the earth's crust and mantle—the Moho—is underway. Present plans call for a floating drilling platform anchored in the open ocean where the earth's crust is the thinnest. Test may go 35,000 ft subsea. Article discusses costs, equipment, problems, techniques and what scientists hope to find.

Exploration

New Fields Spur Gas Search Along Texas Gulf Coast. D. E. Lambert. *World Oil 149,* 113 (1959) Sept. (3 pp.)

Although unsuccessful in ten wildcat attempts, operators are continuing their efforts to prove up a dowdip Hackberry trend indicated by the recent discovery of two of the most promising gas condensate fields along the Texas Gulf Coast in ten years. Gas reserves in the Port Acres Field, discovered in 1957, and in the Port Arthur Field, discovered in 1958, are estimated at nearly one trillion cubic feet. Condensate originally in place in the Port Acres Field was estimated at 24 million barrels. At least that amount is estimated for the Lower Hackberry and Nodorsaria producing zones in the Port Arthur Field.

Oil Prospects in India. A. M. N. Ghosh. *Oil Gas J. 57,* 263 (1959) Sept. 7 (4 pp.)

It is estimated by the Oil and Natural Gas Commission of India that a fairly large area of some 400,000 sq miles of sedimentary basins in India merits consideration for the exploration of oil and natural gas. Author discusses prospects and activities in Assam, Cambay, Cutch, Rajasthan, East Punjab, Bengal Valley, the Ganga Valley, coastal areas, the Andaman Islands and offshore regions.

Foreign Activities

French Plans for Sahara Gas Are Stirring International Interest. *Petrol. Week 9,* 88 (1959) Aug. 14 (2 pp.)

Problem of what to do with gas from the huge Hassi R'Mel field some 200 miles south of Algiers has plagued French energy officials for two years. Overall plan sets down three ways of moving the gas: By pipeline across the Mediterranean or the Straits of Gibraltar; in methane tankers, or by transformation into electricity and movement by high voltage cable. These could be used simultaneously, but first two methods are most favored. Two French groups are negotiating with Constock International Methane on a possible methane tanker deal. Gaz de France and SEGANS are watching Constock's experiments with tanker shipments of liquefied methane. Both groups are investigating the possibility of building a French methane tanker. It is likely that Gaz de France, SN Repal and CFPA will work with the U.S. firm. This would mean a saving of time and money on preliminary research that Constock has already performed.

Government's Review of Oil and Gas in '58. *Progress 3,* 7 (1959) July.

Report from the Ministry of Industries (Pakistan) says that about 19.9 lakh bbl (1 bbl = to 40 imperial gal) of crude oil were produced during 1958. Nine new wells were drilled in various parts of the country and total footage drilled aggregated 97,714 ft. At present eight companies are engaged in exploration, prospecting and production of oil. During the year the oil companies engaged twelve geological, five gravity and six seismic parties to conduct geological, gravity and seismic operations in West Pakistan. In East Pakistan, one geological, one gravity and four seismic parties were engaged.

Heat Pump

Thermoelectric Heat Pump. R. W. Fritts and S. Karrer (assigned to Minnesota Mining and Manufacturing Co.) U.S. 2,896,005 (1959) July 21.

Improved thermoelectric heat pump is claimed in which lead is alloyed with selenium and tellurium, either element forming a useful conductor exhibiting absorption or evolution of heat ("heat pumping effect"). Improved alloys can be formed by adding metallic promoters of both positive and negative effects which have a semi-conductor action.

3. NATURAL GAS AND PETROLEUM PRODUCTION

Drilling

The Changing Scene in Drilling and Producing. G. H. Tausch. *Petrol. Eng. 31,* B-19 (1959) Aug. (5 pp.)

Technological developments continue at a rapid pace and the future will witness even faster development of new tools and techniques. New developments are being hastened by the tightening and downward descent of profits in oil and gas operations everywhere. Article predicts how future oil and gas may one day be developed and produced.

Huge Bit Drills 52-in. Hole. *Petrol. Week 8,* 30 (1959) Aug. 14.

Shell Oil Co. is using a specially designed drill bit to cut 52-in. diam shafts through limestone for a vast LPG storage cavern on its Wood River (Ill.) property. Plans call for the drilling of two main shafts to about 450 ft in the St. Louis limestone. Shafts will be cased by 50-in. pipe to the 150-ft level, and by 42-in. pipe from surface to bottom. When completed, the three-acre cavern will have a capacity of 425,000 bbl of LPG, making it the largest, single, mined LPG cavern in the U.S.

Increased Drill Bit Life Through Use of Extreme Pressure Lubricant Drilling Fluids. M. Rosenberg and R. J. Tailleur. *J. Pertol. Tech. 11,* (T. P. 8074) 195 (1959) Aug. (8 pp.)

Several different types of extreme pressure lubricating additives for use in muds have been developed. These additives are capable of providing a protective lubricating film for bearing surfaces subjected to high load pressures. Comparison tests conducted in the laboratory with 5⅝-in. tricone bits drilling on steel plates immersed in extreme pressure lubricating muds and conventional muds showed that the bearing life of those bits tested in the lubricating mud was three to four times greater than obtained with conventional muds. Drilling tests conducted with extreme pressure lubricating muds in West Texas increased over-all bit life three to fourfold, reduced drilling torque and wear on drill pipe and drill collars.

New Rubber-Sleeve Core Barrel Gets Good Cores in Soft and Unconsolidated Formations. B. L. Austin. *Oil Gas J. 57,* 75 (1959) Aug. 24 (3 pp.)

In extensive field tests in the U.S. and Venezuela, a new rubber-sleeve core barrel has showed high percentages of recovery and excellent quality cores. As the cores are packaged in the rubber sleeve as they are cut, there is no flushing of the core by well fluids after cutting. Barrel includes a hydraulic feed joint that acts as an automatic driller and keeps a constant weight on the bit. This same feedoff principle makes possible a mechanism that pulls the rubber sleeve and core up into the core barrel as the core is formed. This feature relieves the core of any compressive loads and eliminates any possibility of wedging the core in the barrel.

Problem: A Bit for the Turbodrill. *Petrol. Week 9,* 20 (1959) Aug. 28.

Development of a bit for the turbodrill has not kept pace with the progress of the turbodrill itself, according to Dresser Industries, Inc. Big difficulty is in the friction and stress on the bit resulting from the extremely high rotational speed of the turbine. In addition, improvements are needed in present steel alloys, and in heat treating, to give bits the necessary hardness.

Soviets Push Work on Retractable Bits. *Petrol. Week 9,* 25 (1959) Aug. 14 (4 pp.)

Current Soviet efforts are directed toward the creation of an insertible (retractable) bit that can be changed without lifting the drill string. This eliminates the necessity of screwing and unscrewing the drill pipe and of withdrawing and replacing it. Soviet method of casing drilling by means of retractable bits bears a striking resemblance to such tools and methods developed years ago by Carter Oil Co.

Turbodrilling Progress and New Drilling Methods in the USSR. R. A. Ioannesyan, M. T. Gusman, A. A. Minin, G. I. Bulakh, E. I. Tagiev, N. I. Titkov, F. A. Trebin and A. P. Ostrovsky. *World Petrol. 30,* 42 (1959) Aug. (4 pp.); **What the Russians Have New in Drilling.** *Oil Gas J. 57,* 116 (1959) Sept. 14 (5 pp.)

Amount of turbodrilling in oil and gas fields of the USSR increased from 65% of all drilling work in 1955 to 86.5% in 1959. Research work aimed at improving the technique of turbine drilling is subordinated to the task of solving the problem of high-speed drilling of deep wells. Research into friction in the turbodrill thrust bearing has led to the development of rubber-metal thrust bearings working in a fluid medium. In the medium of real drilling fluids friction losses in such bearings approach those in roller bearings. Problem of the life of a rock bit bearing has been solved by new cone-bit designs. The weight-on bit is taken up immediately by the cones, bypassing the bearings. Deep and directional wells are successfully drilled in the USSR by means of electrodrills. Pipeless electrodrill has found favor because of its light weight and portability. To increase penetration in deep wells or deep hard rock intervals, a continuously controlled explosion drilling process has been developed which eliminates the use of mechanical rock crushing tools. When the vibra-

tion drilling method is used, the destruction of the rock is achieved by means of frequent impulses of force transmitted to the rock through the bit cutters provided with blades, teeth or inserts.

Drilling Muds

Problem Drilling Area Tamed by Water Base E. P. Lubricant. W. C. Browning. *Drilling 20,* 71 (1959) Aug. (2 pp.)

Water base extreme pressure lubricants have excellent potentialities to effect economy in drilling through the prolongment of bit bearing life, combating the effects of side wall sticking, providing adequate lubrication necessary in the use of high inhibited muds, affording protection against corrosion damage, and providing lubrication generally in water base fluids.

Exploration

Canada's Arctic Islands Offer 45,000 ft. of Sediments to the Drill. Y. O. Fortier. *Oil Gas J. 57,* 150 (1959) Aug. 17 (8 pp.)

With this summer's survey of Banks and Victoria islands, members of the Geological Survey of Canada will have set foot on all the islands and conducted some systematic reconnaissance investigation on most of them. In the light of such progress and of the varied stratigraphic and structural panorama of the archipelago, one is justified in considering it as potentially of economic interest to the oil and gas industry. All geological systems, except for the Mississippian, are represented in the Arctic Archipelago.

Exploration Perks Up in Eastern Canada, Too. W. A. Roliff. *Oil Gas J. 57,* 191 (1959) Aug. 17 (8 pp.)

During the last few years there has been a marked renewal of interest in the petroliferous regions of Eastern Canada. Exploratory efforts have been intensified in Southwestern Ontario, where commercial petroleum was brought into existence in North America in 1858, and in New Brunswick. In addition to the Southwestern Ontario area, there are four other sedimentary basins in Eastern Canada: The St. Lawrence Lowlands, Gaspe, Anticosti and the Maritimes. These basins range in size from 3000-26,000 sq miles and have a combined area of about 70,000 sq miles. In two of them, Southwestern Ontario and the Maritimes, commercial quantities of oil and gas have been produced for many years. In the St. Lawrence Lowlands and Gaspe, numerous seepages are known, showings of oil and gas have been obtained in a number of wells drilled, and several different kinds of possible traps are present.

Structural Complexities Puzzle Drillers at Southwest Enville—A Development Headache. Part 1. C. C. Reeves, Jr., W. T. Probandt and T. A. Cullinan. *Oil Gas J. 57,* 110 (1959) Aug. 31 (4 pp.); **Part 2. Southwest Enville: Every Well's a Wildcat.** *Ibid.,* 256 (1959) Sept. 7 (4 pp.)

Two years ago southern Oklahoma was considered a poor structural trap prospect; geologists had started to concentrate on the search for likely stratigraphic traps. Then, in the spring of 1957, Texaco, Inc., 1 Westheimer blew in to open Southwest Enville field and to remind geologists that they did not yet know all that lay hidden beneath the Cretaceous overlap. It is ironical that the discovery well was a stratigraphic test searching for the strand line of the basal Oil Creek-Ordovician sand. Discovery of the Southwest Enville structure has shown that the region, with its complex geology, may yet hold even more startling structures.

In Southwest Michigan—Silurian Rocks Have Oil and Gas Potential. G. D. Ells. *World Oil 149,* 88 (1959) Sept. (5 pp.)

Silurian oil and gas possibilities in Michigan merit widespread attention. With some 6700 sq miles of potential territory comparatively unexplored, important new production may be expected from these older and deeper beds. The Salina formation contains three potential oil and gas producing units. No extensive attempt has been made in the past to explore and develop Salina oil and gas resources in Southwestern Michigan. First significant developments began about two years ago and so far Salina oil and gas production has been obtained from Silurian strata beneath or on the flanks of known Devonian Traverse limestone structures.

Geology

A Geologist Looks at One of Canada's Promising Arctic Oil and Gas Prospects. P. W. Rainier. *Oil Gas J. 57,* 120 (1959) Aug. 17 (6 pp.)

Land play that has developed on Canada's northern frontier during the past two years has resulted in the acquisition of over 130 million acres of petroleum and natural gas rights, covering most of the sedimentary basins in the Northwest Territories and the Arctic Islands. Evaluation of gas reserves presents a problem since there is little published information available on the distribution of gas reserves. The ratio of gas to oil reserves in Western Canada up to the end of 1957 is approximately 7150 CF/bbl. Approximately 56% of the gas reserves are in Paleozoic sediments. These sediments predominate in the Lower Mackenzie area. Therefore, using a figure of 4000 CF/bbl, the potential gas reserves could be in excess of 20 trillion CF.

Logging

Sonic Log Proves Valuable Porosity Tool in Oklahoma and Kansas. H. E. Pickhardt and L. M. Halley. *World Oil 149,* 65 (1959) Sept. (5 pp.)

Sonic log has become established as a successful logging tool in Oklahoma and Kansas. Accurate porosity values are obtained by use of the linear relationship between formation porosity and interval transit time. Freedom from statistical variations and independence of mud type and hole size are added advantages. Particular applications of the technique to the Mid-Continent area are demonstrated by actual field examples.

Streaming Potential Phenomena in SP Log Interpretation. H. J. Hill and A. E. Anderson. *J. Petrol. Tech. 11,* (T.P. 8075) 203 (1959) Aug. (6 pp.)

Laboratory data for 155 field muds and 77 shales have been used to develop correlations to estimate the streaming potential component of the SP. Analysis of these data and comparison with field tests show that streaming potential corrections must be made to obtain an accurate estimate of the electrochemical potential for use in the determination of formation water resistivity.

Offshore Operations

How They Drill Offshore Wells in the Canadian Great Lakes. P. S. Bazett. *Oil Gas J. 57,* 142 (1959) Aug. 17 (4 pp.)

Since 1955, Eastern Canadians have been exploring the waters of Lake St. Clair and Lake Erie for new reserves of gas and oil and with admirable success. Principal target is natural gas. A ready market at good prices has stimulated the search, and in 1959, Ontario operators expect to drill a minimum of 110 wells in this profitable offshore campaign. At least 15 drilling towers are expected to be in action during this season; in addition to these, many wells will be drilled from piling platforms. Pioneer company in offshore drilling in Canada was Consolidated West Petroleum, Ltd. It drilled its first well in Lake Erie from a wooden platform in 35 ft of water in 1945. From 1945-9 it continued to drill from a platform based on wood pilings. In 1950, company switched to portable steel platform.

Reservoir Engineering

A Comparison of Theoretical Pressure Build-Up Curves with Field Curves Obtained from Bottom-Hole Shut-In Tests. S. C. Pitzer, J. D. Rice and C. E. Thomas. *J. Petrol. Tech. 11,* (T.N. 2040) 49 (1959) Aug. (4 pp.)

For field experiments a wire-line tubing packer, which can be operated in the tubing against a stabilized flow rate, was developed for bottom-hole shut-in method tests. By use of this bottom-hole shut-in method, pressure humps previously observed in surface shut-in tests were completely eliminated and the effects of afterflow minimized. Analog and digital computer studies have been conducted to obtain theoretical curves for comparison with field curves, and remarkable agreement between the results of bottom-hole shut-in tests and theoretical curves has been obtained.

Laboratory Studies of Formation Damage in Sands Containing Clays. P. H. Monaghan, R. A. Salathiel, B. E. Morgan and A. D. Kaiser, Jr., *J. Petrol. Tech. 11,* (T. P. 8076) 209 (1959) Aug. (7 pp.)

Present laboratory investigations have yielded results which supplement existing literature on formation damage. An expanding-type clay, montmorillonite, was found in hydrocarbon-bearing formations not previously analyzed. When sand columns and formation cores containing montmorillonite were contacted by fresh water, their oil permeabilities were reduced. This reduction in oil permeability was restored partially but not completely by a repair procedure, i.e., flooding with kerosene containing organic agents or flooding with water containing electrolytes. Hence, where montmorillonite is present in formations, prevention of formation damage was indicated to be the only complete solution to the problem. To prevent formation damage, results suggested use of an approximately 1% solution of calcium chloride or stronger solutions of sodium or potassium chloride.

Material-Balance Calculations. H. K. Grant. *Oil Gas J. 57,* 93 (1959) Aug. 24 (6 pp.)

Accuracy of reserve calculations depends on recognition of property variation with elevation. Studies indicate that the saturation pressure-elevation relationship is the most critical factor in reserve estimates. Almost all of the work done to date on small reservoirs involved the use of a single PVT. For most of the cases the errors in using a single or average PVT in estimating oil and gas reserves by material balances are probably small. But for some the errors could be large and may explain why many material-balance calculations have given erroneous results. The hypothetical reservoir used in showing the variation in the physical properties of the fluids is one having a total relief of 1000 ft. All PVT data were determined by applying the physical properties to Standing's empirical PVT correlations for mixtures of California oils and gases.

Secondary Recovery

A Numerical Solution of the Linear Displacement Equation with Capillary Pressure. C. R. McEwen. *J. Petrol. Tech. 11,* (T.N. 2039) 45 (1959) Aug. (4 pp.)

Purpose of article is to present the results of a numerical solution to the one-dimensional water flooding equation in which no outlet end-effect is considered and where there is no flow of water ahead of the flood front. It should be noted that the contemporary paper of Fayers and Sheldon deals with the problem under discussion. For a thorough treatment including both capillary and gravity, the reader is referred to their paper.

What Is Miscible Displacement? W. F. Kieschnick, Jr. *Petrol. Eng. 31,* B-56 (1959) Aug. (8 pp.)

Theory and discussion of high-pressure natural gas sweeping of reservoirs is presented.

World's Biggest Water Flood. D. H. Stormont. *Oil Gas J. 57,* 55 (1959) Aug. 31 (6 pp.)

Operators in the Long Beach Harbor (Calif.) area of Wilmington field are moving ahead at full speed toward establishing the world's largest water flood. Currently about 215,000 bbl/day of ocean brine is being injected in several separate projects. By next July all of the field except the northern and western edges may be under flood. If all goes as planned, at that time more than 1,000,000 bbl of water/day will be going underground through 230 injection wells.

Well Practice

Here's How to Improve Your Gas Lift Installations. Part 2. Simplified Method for Constructing Gas Pressure at Depth Curves. H. W. Winkler. *World Oil 149,* 73 (1959) Sept. (6 pp.)

Surface closing pressure analysis is used to determine the operating valve in many intermittent gas lift installations equipped with casing pressure operated valves. An important part of this analysis is the determination of the surface closing pressures from the closing pressures at depth. Family of gas pressure at depth curves for given data can be calculated rapidly if the increase in pressure due to the column of gas is considered to be a straight line. Only two injection gas pressures at depth must be calculated to establish a set of curves. These two pressures are based on the maximum and minimum injection gas pressures encountered during the unloading and gas lifting operation of a well or group of wells in the same system.

4. GAS CONDITIONING AND LPG RECOVERY

Dehydration

Molecular Sieves for Gas Drying. G. S. Cochrane. *Chem. Eng. 66,* 129 (1959) Aug. 24 (4 pp.)

Since adsorption of hydrocarbons on alumina was the source of the problem of adequate drying of reformer off-gases at Sun Oil Co., it was decided to apply molecular sieves. Unlike other adsorbents, these sieves have precisely uniform pore sizes, allowing them to adsorb certain size molecules while completely rejecting other larger molecules. They are ideally suited for adsorbing water while rejecting aromatics, branch-chained and other large hydrocarbon molecules. At the outlet-end of one of the dryers, a 2-ft layer of activated alumina was replaced with molecular sieves (18 wt % of total desiccant). Alumina in the top 8 ft of the bed was replaced with a load of fresh alumina. The layer of molecular sieves increased the useful life of the desiccant combination from about 1½ - 2½ months.

Hydrogen Sulfide Removal

Hydrogen Sulfide Removal Processes with Moving, Shaped Purifying Solids. W. Sexauer. *Gas- und Wasserfach 100,* 687 (1959) July 3 (4 pp. German text.)

Design and operating principles of the use of shaped granular iron oxide as a purifying agent in fluidized and moving beds are discussed. Operating experience with gas capacity, "rotation", regeneration *in situ* and by sulfur extraction methods, and handling of cycling beds are mentioned.

New Gas Processing Plant Boosts Western Canada's Economy. G. E. Toles. *Gas 35,* 119 (1959) Sept. (4 pp.)

British American Oil's Pincher Creek (Alberta) gas processing and sulfur plant will process natural gas and is the most important supplier of gas to the Trans-Canada Pipe Line. Also, there will be a range of products to help strengthen the economy of western Canada — propane, butane, distillate and sulfur. Plant was built in two stages. Stage 1 plant, designed to recover only distillate and sulfur, returned the partially processed gas into storage reservoirs via gas injection wells, awaiting completion of the Trans-Canada line. The Stage 2 plant will extract the additional products of propane and butane and produce gas of pipeline quality. Plant as presently constructed has 17 buildings, 10 large storage tanks —spherical and cylindrical—and two 20-car railway sidings.

LPG Recovery

Mobil Oil Company's New LPGas Recovery Unit. J. McG. R. Clemie. *World Petrol. 30,* 54 (1959) Aug. (2 pp.)

In order to obtain greater realization from refinery tail gases, Mobil Oil Co. Ltd has recently built an LPG unit at Coryton refinery in Kent. With the start-

up of the unit, which was commissioned in mid-February 1959, propanes and butanes previously burned as fuel gas in the refinery heaters are processed for sale and for use within the refinery as 99 mol.% pure propane and 98 mol.% pure iso-normal butane mixture. Furthermore, this unit will provide useful light off-gases for sale to the North Thames Gas Board and the purification unit for this gas sale was completed at the beginning of July 1959.

Carbon Dioxide Removal

Separation of Normally Gaseous Acidic Components and Methane. F. Kurata and J. P. Kohn. U.S. 2,900,797 (1959) Aug. 25.

According to this invention, a mixture of methane and carbon dioxide is cooled, while maintaining the pressure sufficiently high, sufficient to precipitate solid carbon dioxide from a liquid phase of methane. Resulting liquid phase of methane contains less carbon dioxide than the original mixture and is, therefore, recovered as a product of the process by separating therefrom the solid carbon dioxide.

Hydrogen Sulfide Removal

Separation of Hydrogen Sulfide and Methane. F. Kurata and J. P. Kohn. U.S. 2,901,326 (1959) Aug. 25.

Gas stream containing methane and more than 6 mole % hydrogen sulfide is treated to remove the hydrogen sulfide by subjecting this stream at a pressure of at least 450 psia and a sufficiently low temperature to form two liquid phases, a methane rich liquid phase and a hydrogen sulfide rich liquid phase. Methane rich liquid phase is recovered as a product of the process or may be treated further to remove the remaining hydrogen sulfide therefrom and then recovered as a product of the process. The hydrogen sulfide phase is disposed of as a contaminant or waste, or it is treated for the recovery of the sulfur as a product of the process.

5. NATURAL GAS TRANSMISSION

Compressors

Texas Eastern's Gamble Paying Off. *Oil Gas J. 57,* 58 (1959) Aug. 10 (2 pp.); **Large Electric-Motor and Gas-Turbine Centrifugal Compressor Stations.** P. Reed and G. Kinney. *Oil Gas J. 57,* 177 (1959) Sept. 7 (4 pp.)

Three years ago 15,000-hp electric-motor-driven gas compressors, the largest ever installed on a pipeline, were placed in service at three Texas Eastern Transmission Corp. stations. Today, TET reports these benefits: Lowest initial cost in the industry, as a result of concentrating horsepower in large units. (The Mount Pleasant, Tenn., station now with two 15,000-hp units for added capacity, cost $3,518,000 or $117.27/hp; this is about half the cost of a gas-turbine centrifugal station and one-third the cost of a gas-engine reciprocating station.) Low operating costs, negligible maintenance (normally a major item in gas transmission), and reliability which justified the design are additional benefits.

Fluid Flow

Carbon Dioxide Flows in Pipes and Nozzles. H. V. Williamson. *Nat. Fire Protect. Assoc. Quarterly 53,* 70 (1959) July (13 pp.)

Sufficient data now are available to design CO_2 systems on a performance basis. Those who must inspect and approve installations have a problem. If relative orifice areas and pipe sizes do not indicate enough facts, the problem becomes one of what to inspect. Author looks forward to probable changes in the NFPA Standard for Carbon Dioxide Extinguishing Systems (NFPA No. 12). The listing laboratories probably will be testing components for new information such as the equivalent length of valves and the equivalent area of nozzle orifices.

Development and Evaluation of Gas Condensate Reservoirs. Part 4. W. C. Goodson. *Petrol. Eng. 31,* B-46 (1959) Aug. (3 pp.)

Author discusses gathering system and field processing costs and two-phase conditions in this part. Consideration of both liquid and gaseous phases flowing simultaneously in pipelines is becoming more of a serious problem in the design of both gathering systems and major transmission lines. Reference is made to a paper by Ovid Baker (see *Gas Abstracts 14,* 214) in which consideration is given to the magnitude of this problem along with a plea for more and better data particularly for lines larger than 10-in. in diameter.

New Correlation for 2-Phase Pipeline Flow. J. A. Chavez. *Oil Gas J. 57,* 100 (1959) Aug. 24 (3 pp.)

Two-phase flow of liquid and gas occurs in many industrial plants where heating and cooling of the fluids being processed are required. Pipeline designer needs to estimate pressure drops with a certain degree of accuracy. Several correlations have been published to solve this problem; however, none of these correlations have proved their reliability when applied to flowing conditions different from those for which they were developed. This correlation relates the different variables which have apparent effect upon the two-phase flow of fluids in pipelines. Work of preparing this correlation was undertaken as a step towards grouping the wide range of data which have been available to the author and presenting

them in a generalized form for easy application in computing pressure drops under conditions of two-phase flow. By relating the many different variables this correlation presents a new concept in the treatment of two-phase flow problems.

Metering

Mass-Flow Measurement — Why? How? H. P. Bean. *Oil Gas J. 57,* 87 (1959) Aug. 10 (3 pp.)

Heat energy in a pound of natural gas varies less with composition changes than does heat energy on a cubic foot basis. For this reason it makes sense to measure gas by weight rather than by volume. Three different methods of measuring weight of flow gas have been tested and proved accurate. More testing is necessary before they are universally accepted. Reliability and accuracy acceptable now will improve with experience and research. Mass measure would eliminate the need to define standard conditions. Gas can be measured by the pound without regard to pressure or temperature either at flowing conditions or at some assumed base conditions. Also, heat energy of any given gas on a pound basis will be the same regardless of delivery conditions.

Pipeline Construction

How to Use Aerial Photos in Pipelining. J. D. Mollard. *Pipe Line Ind. 11,* 31 (1959) Aug. (4 pp.)

Much has been written in the last 15 years on the identification of soil and bedrock types using aerial photos. In addition to local topographic irregularities and surface drainage conditions, a good deal can be told about the composition and condition of the surficial materials. Under certain circumstances, a fairly reliable estimate can be made as to whether or not bedrock will be encountered in the trench to be excavated. Some of the features that normally require recognition and evaluation, especially where alternate competitive routes are indicated from aerial photos, are: 1) Potentially unstable slope conditions along the line; 2) river crossings; 3) slopes so steep that they necessitate difficult and costly construction; 4) hard rock excavation and dense boulder concentrations; 5) places where the pipe may be exposed; 6) numerous lakes and smaller water-filled rock basins; 7) deep floating bogs, marsh and swamp; 8) permafrost and related frost-action phenomena, and 9) marked variations in the salt content of soils.

Operation Stopple. *Gas 35,* 31 (1959) Sept. (4 pp.)

On a recent pipeline construction job by Michigan Wisconsin Pipe Line Co., rather than shut down the pipeline leading into Green Bay, Wis., during the time required to install a prefabricated mainline valve assembly, stopples were installed. Use of stopples, together with a temporary hook-up of 6-in. diam bypass piping between the stopples, made it possible to continue a flow of gas to Green Bay. Article describes installation technique.

Pipeline Operations

Install Flow Controls and Use Laterals for Gas Storage. J. A. Bonner. *Pipe Line Ind. 11,* 44 (1959) Aug. (2 pp.)

By keeping lateral lines pressured between the transmission line tap and the town border station, and exercising control over maximum flow, both pipeline and distribution company can effect natural gas storage that will help shave the peak demands that come in cold weather. Installation of a flow controller at the transmission line tap controls the upper flow limit and holds a downstream pressure differential of about 7 psi maximum. A bypass will open when pressure falls to a predetermined low point. This keeps the lateral line pressured all the way to the town border station, but, at the same time, it will not permit excess flow (above contractual purchase agreement) from the pipeline.

Pipelining at 30 Below. J. S. Black. *Oil Gas J. 57,* 136 (1959) Aug. 17 (3 pp.)

Thirty degrees below zero is not an uncommon thermometer reading in Saskatchewan and occasionally 40° below zero is reached. Heavy snow and high winds make roads impassable. In this weather problems of oil transportation are multiplied. Stationary oil congeals in idle lines, gasoline engines refuse to start and a gager has been known to break through ice before he could measure the oil below. Despite this, there are rewards to be had says author who was a pipeliner in Texas until he moved to Canada in 1956.

Why Offshore Pipelines Should Be Buried. S. V. Collins. *Gas Age 124,* 20 (1959) Sept. 3 (2 pp.)

Methods, costs and advantages of burying offshore pipelines are discussed. In addition, author presents details of a jet-type submarine trenching machine, one of the more recent advances in the field of underwater pipeline laying.

Pipeline Systems

Eastern Shore Natural Gas a Model for Regional Pipeline Planning. *Gas 35,* 78 (1959) Sept. (4 pp.)

Eastern Shore, owned by Chesapeake Utilities Corp., exemplifies modern regional pipeline planning in two important respects: 1) Company stresses economical automatic operation. (This assures a profit within the narrow range between its payments to Transcontinental Gas Pipe Line Corp. and the prices

Eastern Shore is legally allowed to charge its customers), and 2) the company, from its initial planning to final construction, has made provision for rapid expansion in line load. The pipeline has a 24 MMCF/day capacity—almost three times the load it is carrying at present.

6. GAS AND LPG STORAGE

Liquefaction

You Don't Need Pressure Vessels for Liquid Gas. *Can. Chem. Processing 43,* 64 (1959) Aug. (3 pp.)

Methane and ethylene—two of the most common pipeline-transported gases—are now commercially moved by insulated carriers. The converted tanker, Methane Pioneer, last February carried the equivalent of 32,000 bbl of liquid methane from the U.S. Gulf Coast to Great Britain. A North American "first" was accomplished when Imperial Oil shipped liquid ethylene from its Sarnia plant to the Carbide Chemical petrochemical works in Montreal East. Carbide solved a serious logistics problem when its parent company built two specially-designed tank trailers to transport liquid ethylene. As yet, details on the design of the tank trailers have not been released.

Methane Liquefaction

What's New in Transportation and Storage. *Petrol. Week 9,* 37 (1959) Aug. 28.

Methane Pioneer, first tanker to make ocean shipments of liquid methane, has passed its first inspection by the American Bureau of Shipping and Lloyds Registry of Shipping. After three successful voyages from Lake Charles, La., to Great Britain, the tanker was pronounced in excellent condition. Tanker began its fourth voyage in mid-August.

Underground Storage

Aquifers: Low-Cost Gas Storage, Close to Markets. *Petrol. Week 9,* 48 (1959) Sept. 4 (2 pp.)

In several key Midwest market areas, aquifers—or underground, water-bearing formations—are providing dollar-saving gas storage for space-pressed suppliers. Throughout the summer, Natural Gas Storage Co. of Northern Illinois has been working to enlarge its famed Herscher dome, the first aquifer to be used for gas storage, and to find others nearer its Chicago market. Development of a large aquifer a few years ago by Laclede Gas Co. near St. Louis enabled that company to move 100,000 homes from its waiting to its customer list. Northern Natural Gas Co., also counting increasingly on aquifer storage, may soon have the biggest aquifer storage project in the industry at Redfield, Iowa, where the company is building facilities to develop an aquifer with ultimate storage capacity of 50-billion CF.

Constructing Underground Storage Facilities with Nuclear Explosions. R. H. Carlson. *Petrol. Eng. 31,* B-32 (1959) Aug. (3 pp.)

Use of nuclear explosives in the construction of underground oil and gas storage tanks is one of the Atomic Energy Commission's studies under the "Plowshare" program. Statistics show that underground storage has become increasingly popular. According to the National Petroleum Council, the amount of fuel stored underground increased from 7 million bbl in 1952 to 25 million bbl in 1956, and projects are underway to expand this capacity even further. Although several types of underground storage are being developed, only the construction of caverns in impermeable rock is of interest from the viewpoint of using nuclear explosives. Total storage capacities of these caverns is at present about 1.5 million bbl. Most of the caverns are used for storage of butane and propane; they range in capacity from some 260,000 bbl to 25,000 bbl.

Liquefaction

Liquefied Gas Pressurizing Systems. J. J. Shanley (assigned to Air Products, Inc.) U.S. 2,896,415 (1959) July 28.

Volatile liquids (liquid oxygen) in liquid phase at low pressure are transferred to a receiver under high pressure by arranging levels to provide gravity flow from supply vessel to a transfer vessel, and by simultaneous operation of periodic valves. These valves isolate the transfer vessel from the supply vessel and subject it to the relatively high pressure of the receiver vessel during gravity transfer. This pressure is vented momentarily from the transfer vessel to the supply vessel on the next valve change.

Methane Liquefaction

Means for the Transportation and Storage of Cold Boiling Liquefied Hydrocarbon Gas. J. J. Henry (assigned to Constock International Methane Ltd.) U.S. 2,896,416 (1959) July 28.

Ship structure is claimed for storing and transporting of liquefied gases of boiling point of –40° F which comprises a tank mounted within an insulated housing so as to permit lateral and vertical expansion of the tank. This housing is designed to form an inner hull of the ship braced by hollow-spaced cofferdams crosswise of the vessel. This novel feature is for provision of water sprays and circulation between hulls to cool the inner hull and maintain it at a safe temperature against damage from cold. A companion manifold of steam sprays is provided for heating and controlling tank temperatures.

Methane Liquefaction Cycle. S. E. Tung (assigned to Constock Liquid Methane Corp.) U.S. 2,896,414 (1959) July 28.

Methane liquefaction cycle is claimed in which gas from a well above critical pressure is expanded in initial stages with performance of work to 550 psia. The acid gases then are removed and intermediate stages of heat exchange with a propane and an ethylene cycle are provided. A final stage permits expansion of part of liquid methane to obtain reduction to atmospheric pressure and about –242° F for liquid storage, where heat is also recovered for intermediate stage cooling.

Storage and Transportation of Liquefied Gas. W. H. Rupp (assigned to Esso Research and Engineering Co.) U.S. 2,897, 657 (1959) Aug. 4.

Improved method for bulk marine transport of liquefied hydrocarbons (methane) is claimed comprising an inner lined housing, preferably with a rigid insulating material, an inner metal tank for CH_4 with a space between inner tank wall and inner lining to be filled with a layer of solid carbon dioxide, the latter to act as a heat-flow barrier and also as a fire protective gas blanket for the ship holds.

Underground Storage

LPG Removal from Underground Storage. E. E. Reed (assigned to Phillips Petroleum Co.) U.S. 2,895,305 (1959) July 21.

Liquefied petroleum gases are withdrawn from an underground storage cavern by the gas-lift principle, in which the surface compressor draws upon the LPG standpipe extending to the bottom of the cavern vaporizing LPG-forming gas which lightens and lifts the LPG in the pipe and carries it to a surface separating tank. Here the separated gas is returned by the compressor through an annular pipe (surrounding and warming the LPG outlet pipe) to the top of the cavern while the separated LPG is loaded out to storage.

Underground Storage. L. P. Meade (assigned to Phillips Petroleum Co.) U.S. 2,896,417 (1959) July 28.

In an underground storage cavern system for liquefied petroleum hydrocarbons, consisting of rooms or caverns interconnected at the top and bottom by separate tunnel systems which connect to the surface by a vapor shaft and an unloading pipe, respectively, improvement is claimed in a process of withdrawing vapors from the cavern. The vapors are compressed and condensed to remove the lightest components as fuel gas, and the condensate is returned continuously to the cavern to cool and dissolve stored material thereby reducing and controlling cavern pressure to prevent leakage.

7. MANUFACTURED GAS AND CHEMICAL PROCESSING

Coal Hydrogenation

Agglomeration Studies in the Low-Pressure Hydrogenation of Coal in a Fluidized Bed. W. Kawa, R. W. Hiteshue, W. A. Budd, S. Friedman and R. B. Anderson. *U.S. Bur. Mines Bull. 579* (Washington: U.S. Govt. Printing Office, 1959, $.15) (10 pp.)

Agglomeration is one of the principal difficulties in the low-pressure dry-coal hydrogenation of bituminous coal in a fluidized system. Experiments with small batches of noncoking bituminous coal in a semicontinuous system have shown that agglomeration may be reduced or eliminated by employing a comparatively slow heating rate, by pretreatment at 400° C with or without hydrogen, by impregnating with alkali carbonate or ammonium molybdate, or by dilution with material such as char. To obtain maximum yields of oil, residence time in the 400°-500° C temperature range must be sufficiently long. No difficulties were experienced with agglomeration of a Texas lignite.

Desulfurization

Hydrodesulfurization of Coke. R. B. Mason. *Ind. Eng. Chem. 51,* (Part 1) 1027 (1959) Sept. (4 pp.)

Because fluidized coking of high-sulfur residual stocks produces coke with a relatively high sulfur content, a study was undertaken to develop methods of reducing the sulfur level to about 1%. Treatment with various gases, according to procedures described in the literature, was not satisfactory. Coke produced from fluidized coking of a high sulfur residuum was effectively desulfurized when preoxidized with air at low temperatures (650°-700° F, atmospheric pressure) to a 90-94% coke yield and then treated with hydrogen at about 1400° F and 1-3.5 atm. Sulfur content was reduced from 7 to 1% after 2 hours at atmospheric pressure and after 1 hour or less at 3.5 atm.

Fischer-Tropsch

Synthetic Liquid Fuels from Hydrogenation of Carbon Monoxide. Part 2. Cobalt and Iron Catalysts for the Fischer-Tropsch Synthesis: Preparation and Characterization of Catalysts, Synthesis Tests, and Reaction Mechanism. J. F. Shultz, L. J. E. Hofer, E. M. Cohn, K. C. Stein and R. B. Anderson. *U.S. Bur. Mines Bull. 578* (Washington: U.S. Govt. Printing Office, 1959, $1.00) (139 pp.)

Publication constitutes second report on laboratory studies of the Fischer-Tropsch synthesis. The first (Bureau of Mines Technical Paper 709) contains a

review of the literature and results of the Bureau's research on cobalt and iron catalysts through 1946. Present bulletin completes the account of studies of cobalt catalysts and summarizes work on iron catalysts through 1953. It contains extensive data on catalytic and other properties of iron carbides, nitrides and carbonitrides. In contrast to cobalt and nickel carbides, carbides of iron, as well as iron nitrides and carbonitrides, are active in the synthesis. Iron nitrides and carbonitrides are shown to have advantages over reduced- as well as carbided-iron catalysts in activity, life and selectivity. Iron nitrides are rapidly transformed to carbonitrides in the synthesis, and the behavior of nitrided catalysts may be attributed to the presence of carbonitride phases. Products from iron carbonitrides contain more material boiling in the gasoline range and less heavy oil and wax than those from iron carbides. A much larger amount of the product from carbonitride is oxygenated material. Since only the hybrid structure has been found in active, used catalyst, bulk cobalt carbide cannot be an intermediate phase in synthesis. Furthermore, cobalt carbide is not an active phase in synthesis because its activity is very low compared with that of metallic cobalt.

Hydrocarbon Recovery

Operating Costs of Gas-Recovery Plants. W. L. Nelson. *Oil Gas J. 57,* 109 (1959) Aug. 3 (2 pp.)

Operating data and costs on gas recovery plants in refineries are presented.

Hydrogen

Small Volume Pure Hydrogen at Bulk Cost. *Chem. Eng. 66,* 60 (1959) Aug. 10 (3 pp.)

Van de Mark Chemical's plant, Linden, N.J., employs a new low-temperature purification technique that is going through its initial paces turning out 99.99% hydrogen (less than 75 ppm hydrocarbons, less than 10 ppm CO) from a complex refinery offgas—at a price competitive with electrolytic hydrogen. For the blend of high quality at low cost uniquely designed heat exchangers, where indirect cooling with liquid nitrogen fractionally condenses impurities in the feed, should be credited.

Hydrogenation

Hydrogenation and Dehydrogenation. J. T. Bradbury, W. M. Keely, F. J. O'Hara and R. F. Vance. *Ind. Eng. Chem. 51,* (Part 2) 1111 (1959) Sept. (10 pp.)

Literature review indicates that Fischer-Tropsch synthesis, reduced to limited oil areas, awaits economic justification in areas of plentiful oil. In oxy synthesis a considerable amount of work still continues on different forms in which to introduce cobalt catalysts to the reactor and ways to remove cobalt carbonyl from the reaction products. Ammonia synthesis no longer is a booming research frontier evidenced by the continuing shrinkage in the volume of literature. Continued interest has been shown in the selective hydrogenation of acetylene in the presence of other reactive groups. Interest in hydrodesulfurization of petroleum products and related processes remains at a relatively high level. Considerable data have been published with regard to improvement of the activity, life and selectivity of hydrogenation and hydrogenolysis catalysts. Study of gas adsorption and diffusion continues with attempts to relate the ability of metals to absorb hydrogen to their position in the Mendeleev periodic system. Bibliography cites 369 references.

Methane

Britain Drains Methane from Coal Mines. J. Grindrod. *Gas Age 124,* 30 (1959) Sept. 3 (4 pp.)

Article tells how Britain's National Coal Board is using modern techniques in recovering methane from its coal mines. Originally intended as a safety measure, process now helps supply town gas, or is burned under boilers in collieries. Estimated potential recovery is 300 MMCF/day.

Oil Shales

Petrographic Examination and Chemical Analyses for Several Foreign Oil Shales. H. N. Smith, J. W. Smith and W. C. Kommes. *U.S. Bur. Mines Rep. Invest. 5504* (Washington: U.S. Govt. Printing Office, 1959, $.35) (34 pp.)

Progress of foreign countries in developing and using oil shale as a source of liquid fuels was studied by technical missions of the Federal Bureau of Mines as a basis for oil shale investigations to be undertaken in the U.S. Oil shale mines, retorting plants and refineries were visited; geological information on the nature and occurrence of the foreign oil shales was obtained, and samples of the oil shales were collected where possible. Samples collected by these missions or acquird by other means came from Australia, Brazil, Canada, France, Manchuria (China), New Zealand, Scotland, Spain, Sweden, Thailand and the Union of South Africa. These countries represent a large part of the locations where oil shade developments have taken place. The major omissions are the Estonian, German and Russian developments. Information given in the report provides data necessary for comparing these selected oil shales of worldwide interest and evaluating the applicability of their respective processing methods to other oil shales. The grades and amounts of oil shale and shale oil are expressed in U.S. gallons of 231 cu in., barrels of 42 U.S. gallons, and U.S. short tons of 2000 lb.

Ore Reduction

Sponge Iron by the HYL Process. F. W. Starratt. *J. Metals 11,* 315 (1959) May (4 pp.)

HyL process is a batch process in which rich, lump iron ore is reduced in a retort by hot, reformed natural gas. Gas enters the retort in a steady flow from the top of the reactor, passes through the ore bed, and then out the bottom of the vessel. Thus, there is no pulsating action. In the reforming process, the natural gas is first passed through a preheating coil in one of two Kellogg reforming furnaces. Next it is passed through a desulfurizing drum, and then through the reformer coils where natural gas and steam react to produce hydrogen and carbon monoxide in the presence of a catalyst. Hot gas leaving the reformer flows through a waste heat boiler and is then sent to a scrubbing tower to quench the gas and remove the excess water. The cool, dry gas is then preheated in a heater which is fueled with spent reducing gas from the process. The hot, reformed gas comes in contact with iron ore in the primary reactor and is subsequently water quenched in a secondary gas tower to remove water formed in the reduction reaction. Gas is reheated and passed through a secondary reactor, which has been charged with fresh ore. Gas is again water quenched. Finally, the dry, cool gas is used as fuel for the reforming furnaces and preheaters.

Petroleum Refining

Chemical Engineering Reviews. Thermal and Catalytic Decomposition of Hydrocarbons. A. J. deRosset and C. V. Berger. *Ind. Eng. Chem. 51,* (Part 2) 1075 (1959) Sept. (6 pp.)

From the literature it is evident that new techniques, only beginning to be exploited, are the shock tube and plasma jet. They promise to open new fields of hydrocarbon chemistry of both theoretical and practical significance. Pyrolysis of light hydrocarbons in the presence of steam to produce ethylene is currently the most significant thermal cracking process. Effect of gasoline composition on engine performance and smog forming tendencies will influence future processing methods. Olefins produced predominantly by catalytic cracking are being subjected to criticism on both counts. Interesting aspects of radiation chemistry of hydrocarbons deal with the effect of γ-rays and neutrons on lubricants. Development of a radiation-resistant base stock, with inhibitors against radiation-induced decomposition, is another challenge presented by the nuclear age. Bibliography includes 92 literature references.

Plant Wastes

Engineering and Maintaining In-Plant Air Pollution Control. O. C. Thompson. *J. Air Pollution Control Assoc. 9,* 94 (1959) Aug. (3 pp.)

Outline and discussion of five-step written policy of Union Carbide Chemicals Co. which covers specifically process wastes and related community relations. According to this policy, the design engineering departments are responsible for incorporating into the design of any new installations the means for disposal of all process wastes with a minimum of disturbance to the community. In addition, each operating plant assigns some individual with the responsibility for proper disposal of waste, engineering and laboratory talent for continuing studies of waste disposal and a company representative to the public on all matters pertaining to air or water waste disposal. Finally each operating plant takes an active part in any local committee groups or branches of agencies or trade associations interested in industrial waste disposal.

Pyrolysis

Chemical Engineering Reviews. Pyrolysis of Coal and Shale. C. H. Prien and M. Perch. *Ind. Eng. Chem. 51,* (Part 2) 1142 (1959) Sept. (6 pp.)

Research in coal carbonization continued, according to the literature survey, on a wide front on both the fundamental and the practical scale. Studies on fundamentals of coal pyrolysis included isolation of fusible primary pyrolysis fractions of coal by chloroform extraction, kinetics of evolution of gases other than tar and use of the molecular still and the refractometer for following thermal decomposition. Interest in low temperature carbonization has continued. A comprehensive compilation of Fischer low temperature assay data for 400 coals was published, as well as an investigation of free radicals trapped in low temperature carbons. By far the most intensive basic research on oil shale is being performed by the Russians. An excellent review of postwar fundamental research on Estonian shale appeared. Only a few studies of any consequence on U.S. shales were published. Robinson and Cummins extracted Colorado oil shale kerogen with Tetralin at 25°-350° C. Brower and Graham subjected Colorado oil shale kerogen to chlorination, hydrobromination, nitration, sulfonation, air oxidation and acetylation. Bibliography cites 105 references.

Reformed Gas

Uniform Heat Raises Reformer Output. *Chem. Eng. 66,* 62 (1959) Aug. 24 (3 pp.)

California Ammonia Co.'s new anhydrous ammonia plant at Lathrop, Calif., features innovation on standard, conventional chemical process. On stream since early January, this plant boasts a synthesis gas section that is setting new performance levels because of a new type of steam-methane reformer. Another modified steam-methane reformer is on the way. It

features a special modification of the well known gradiation heater used in petroleum refineries and ethylene plants.

Acetylene

Separation of Acetylene from Methane Cracking Gases by Means of a Selective Solvent. G. Fauser (assigned to Montecatini Societa Generale per l'Industria Mineraria e Chimica.) U.S. 2,894,602 (1959) July 14.

Improved recovery process for pure acetylene from partial combustion gases is claimed in which CO_2 is removed at 13 atm and 25° C by scrubbing with ammonia. Moisture is next removed by cooling to 3° C and then scrubbing with menthanol at –25° C and higher acetylenes next are removed by cooling to –80° C and methanol scrubbing and removing final amounts of acetylene by a second scrubbing with methanol. The preliminary methanol scrubbing solutions are decompressed and fractionated to separate H_2, CO, acetylene and higher acetylenes.

Hydrogen

Isotope Concentration System. J. S. Spevack. U.S. 2,895,803 (1959) July 21.

Hydrogen and its isotopes (deuterium) are separated by a liquid-gas contacting scrubber which concentrates the deuterium as heavy water by countercurrent contact at high and low temperatures. Water to be treated enters the top of a cold tower, passes through and then is fed to the top of a hot tower passing through to waste at the base. Hydrogen sulfide is continuously recycled countercurrently from an outlet at the top of the cold to the bottom of the hot tower. Several stages of hot and cold pairs operate as a series. Cold tower equilibrium causes removal of deuterium sulfide from gas and its ionic conversion to heavy water at the bottom. Hot tower acts as a stripper and the partially enriched water stream at this equilibrium returns deuterium to the gas and the water leaves the bottom of the hot tower depleted in deuterium. Enriched gas acts as deuterium reflux in the next cold stage with growing concentration. This process was recently publicized through Supreme Court prevention of its disclosure by AEC declassification prior to issue of patent.

Ore Reduction

Process of Fluidized Bed Reduction of Iron Ore Followed by Electric Furnace Melting. B. S. Old and R. W. Hyde. U.S. 2,894,831 (1959) July 14.

Improved process for reduction of iron ore is claimed comprising a two-zone shaft furnace containing a fluidized upper preheating bed and a lower reducing bed fed by overflow from and with dust recovery from off gases, and a lower overflow for reduced product to a shaft-type electric furnace for melting of the reduced ore.

Reformed Gas

Apparatus for Reforming Hydrocarbons. L. A. Stengel (assigned to Commercial Solvents Corp.) U.S. 2,894,826 (1959) July 14.

Improved reforming apparatus for hydrocarbons is claimed in which a multiplicity of vertical catalyst packed tubes fed from a manifold are suspended from the roof of a furnace chamber and pass slidably into a lower chamber packed with catalyst. Gas burners heat the upper space surrounding the tubes. The reformed gas is withdrawn from below the lower catalyst bed.

Synthesis Gas

Process and Apparatus for Gas Purification. J. Wucherer, H. Linde and F. Jakob (assigned to Gesellschaft fur Linde's Eismaschinen A.G.) U.S. 2,895,304 (1959) July 21.

Improved separation of a high-hydrogen gas is obtained by precooling in exchangers and scrubbing with a pure nitrogen wash-liquid from a two-stage air separation plant. This scrubbing yields a pure hydrogen-nitrogen mixture for ammonia synthesis, said mixture being used for precooling entering gases regeneratively in both hydrogen and air separating plants.

8. GAS DISTRIBUTION

Distribution Systems

Design and Installation of Standardized Regulator Vaults. W. T. Harper. *Gas 35,* 59 (1959) Sept. (3 pp.)

Since 1956 New Haven (Conn.) Gas Co. has been installing open-pit sidewalk regulator vaults. They are designed by the engineering department. Seven vaults have been installed and four more are planned for this year. Advantages such as ease of access, safety, adequate lights, good ventilation and freedom from traffic hazards make these vaults highly desirable. All contribute to ease with which regulators can be serviced.

Leakage

Formulating an Emergency Leakage Control Plan. C. V. Kroeger. *Gas Age 124,* 17 (1959) Aug. 20 (3 pp.)

Author draws upon an extended gas utility experience to offer a checklist for use in preparing an emergency plan. Such a plan will give management assurance that desired procedures are actually being

followed, will assist in averting disaster and help in maintaining public confidence by swift execution of emergency plans.

Metering

Measuring Wet High Pressure Gas. C. C. Cooper. *Gas 35,* 117 (1959) Sept. (2 pp.)

Northern Natural Gas Co. (Omaha, Neb.) has been using dry-type meters for only about a year. Company does not expect to completely eliminate measurement freezing troubles in wet gas, high-pressure field because of this. During the winter season when atmospheric temperatures in the Texas Panhandle are below 32° F, measurement freezes will be encountered to some degree. Company's efforts are directed to controlling and eliminating these problems wherever possible. Use of dry-type orifice meters has reduced to a minimum poor measurement due to freezing and hydrate conditions.

Niagara Mohawk Centralizes Meter Maintenance Work. J. Dugan. *Gas Age 124,* 17 (1959) Sept. 3 (3 pp.)

Niagara Mohawk Power Corp. (Syracuse, N. Y.) recently consolidated all meter maintenance work at a new plant incorporating the latest equipment. New shop, replacing three older ones, is accessible from 22 gas field service departments. New shop is capable of handling over 10,000 meters/month, and has given at least 25% higher output/manhour via electronic provers, overhead conveyor system and other improvements.

Positive Meters Can Be Used in High-Pressure Measurement. W. C. McDonnell. *A.G.A. Monthly 41,* 26 (1959) Sept. (6 pp.)

For many years nearly all high-pressure measurement was recorded by orifice meters. Positive meters were generally associated with measurement at relatively low pressures, and the effect of deviation or suprcompressibility of natural gas at these pressures was small and generally ignored. However, with operating costs continually increasing, together with the development of improved positive meters and techniques for properly utilizing these meters, the situation is changing. Many positive meters now are being used for high-pressure measurement. Advantages to be gained by metering at high pressure are: 1) Available pressure is conserved, allowing for smaller size piping;) meter size is smaller, thereby conserving space, and 3) costs of high-pressure metering facilities may be much less than the cost of equivalent capacity low-pressure facilities. Author describes some of the sizes and models of high-pressure positive meters available.

Odorization

Weigh Odor Control Methods Carefully. W. Viessman. *Heating, Piping & Air Conditioning 31,* 94 (1959) Sept. (6 pp.); **Cause and Control of Odor in Air Conditioned Spaces.** W. Viessman. *Air Conditioning, Heating and Ventilating 56,* 77 (1959) Sept. (5 pp.)

To eliminate or abate an odor condition in an air conditioned space it is necessary either to remove the offending gases or vapors or reduce their concentration. Sources of odors are many, and detection and measurement must ultimately rely on human appraisal. Odors are affected by temperature and humidity. They may not only be objectionable to the sense of smell, but may also cause irritation to the nose and throat. Some of the physical methods for removal are by ventilation with outside air, air washing or scrubbing, charcoal adsorption and masking. Chemical absorption or destruction of odor sources, vapor neutralization, masking and catalytic combustion are other means. For a given building the quantity of outside ventilation air admitted should be in accord with engineering standards and local codes. Author presents an example of possible economies and comparative investment and operating costs of an outside air system and a recirculating air system.

Plant Operations

Power Light Water. T. W. Clapham. *Gas World 150,* 60 (1959) Aug. 22 (8 pp.)

Article is concerned with an assessment of the technical and financial considerations connected with power, light and water as applied to the production and distribution of gas. Information presented has been obtained from experience in planning and commissioning of various types of power plants and power users, their cost and utilization value when viewed in retrospect, and what is more important the savings which have been realized since their installation. Author shows past and present methods of steam utilization on gas works connected with traditional coal carbonizing plant and also for carburetted water gas and other cyclic gas making plants. Power problems which are applicable to both large and small works are given. Author presents examples of various types of prime movers for compressing gas and has shown the effect of capital and running costs by assessing these on the cost index basis.

Weather Forecasting

Degree-Days and Dollars. T. O. Johnson. *Fueloil & Oil Heat 18,* 82 (1959) Sept. (2 pp.)

With positive degree-day information, i.e., degree-day information which compensates for wind, sun

and mild weather conditions, the size of drops can be increased. With more accurate degree-day information, profits can be increased. With this in mind, the Fuel Demand Meter was developed. It determines the average daily temperature by "integrating" sub 65° temperature. By proper design it was possible to make the meter account for increased fuel consumption caused by wind and decreased fuel consumption caused by the effect of the sun's radiation. These effects are in direct proportion to fuel consumption. Data are included to indicate the extent to which the meter accomplishes its purpose.

9. GAS FUEL UTILIZATION AND APPLIANCES

Air Conditioning

Sizing and Laying Out for Evaporative Cooling Systems. O. M. Johnston. *Air Conditioning, Heating and Ventilating 56,* 74 (1959) Sept. (2 pp.)

American Society of Heating and Air Conditioning Engineers has conducted considerable research in recent years on the designing of evaporative air cooling systems. Some very basic and sound methods of calculating air volume requirements and designing air distribution systems have resulted. In designing an evaporative air cooling system, the first consideration is to determine, as nearly as possible, the actual climatic condition of the area, the range and frequency of simultaneous wet bulb and dry bulb temperature readings and other data to assist in determining air design temperatures. Next the sensible heat load of the building or space being cooled is considered. After the necessary air volume is determined, the next step is to design a distribution duct system that will efficiently and effectively distribute the air.

Combustion

Chemical Engineering Reviews. Combustion. R. Friedman and J. H. Grover. *Ind. Eng. Chem. 51,* (Part 2) 1067 (1959) Sept. (8 pp.)

Review of the literature shows that combustion research emphasis apparently has shifted from homogeneous gaseous combustion to work with more complex systems involving condensed phases. This may be partly associated with increased confidence on the part of scientists to undertake more difficult problems as their knowledge increases, and may be partly due to the changing nature of applications of greatest interest. In any case, interest in comprehending the combustion process in its various manifestations continues at a substantial level. Bibliography cites 215 items classified according to solid-propellant rocket combustion, liquid-propellant rocket combustion, combustion in furnaces, combustion as a tool for chemical synthesis, gaseous combustion research, droplet-combustion research, and books and reviews.

Drying

Gas Points the Way to Faster Drying of Rough Rice. H. W. Schroeder and D. W. Rosberg. *Ind. Gas* (Amer.) *38,* 12 (1959) Aug. (4 pp.)

Small-scale laboratory tests were conducted in 1958 to determine the effects of infrared radiation from a gas-fired "Schwank" infrared 48,000 Btu heater on drying of rough rice. These experiments indicated possibilities for development of a faster method of drying rice and other agricultural products than conventional systems now in general use. Drying rates ranging from 3.60-0.49% moisture removed per minute of exposure to infrared were obtained. Yield of head rice was increased significantly over yield of head rice from control samples air dried at room temperature.

Flame Research

Comparison of Different Methods of Fluid-atomizing Oil Flames and the Effect on Flame Emissivity and Radiation of the Addition of Carbon Black to Liquid Fuels. 1. Comparison of Different Methods of Fluid-atomizing Oil Flames. E. H. Hubbard. *J. Inst. Fuel 32,* 328 (1959) July (10 pp.)

Articles introduce the fifth of the series of reports of the work of the International Flame Research Foundation to appear in the Journal. Objective of these experiments was to compare the effects of different methods of fluid-atomizing an oil flame. Main conclusion is that in a turbulent jet diffusion flame the burner reaction thrust is the principal variable, the method by which this thrust is obtained being of less importance. Thus the use of a small nozzle at high pressure, or a properly designed convergent-divergent nozzle, or the addition of preheat to the atomizing fluid, all result in a saving of atomizing-agent mass but have little effect on the properties of the flame. The total radiation from an air-atomized flame is the same as that from one atomized with steam but it is more uniformly distributed over the flame length. The temperature of an air-atomized flame is higher.

Comparison of Different Methods of Fluid-atomizing Oil Flames and the Effect on Flame Emissivity and Radiation of the Addition of Carbon Black to Liquid Fuels. 2. The Effect on Flame Emissivity and Radiation of the Addition of Carbon Black to Liquid Fuels. E. H. Hubbard. *J. Inst. Fuels 32,* 338 (1959) July (6 pp.)

In these experiments a 50/50 suspension of carbon black in fuel oil was added in turn to a gas oil and

a fuel oil. The effect on turbulent jet diffusion flames burning these mixtures was to increase the flame emissivity at a fixed distance from the burner roughly in proportion to the increase in C:H ratio. The increase seemed more pronounced at the tail of the flame. In the case of fuel oil there are technical difficulties in keeping more than about 6% of carbon by weight in suspension for long periods and in industrial practice it is usual to inject the carbon as near to the burner as possible.

Effect of Molecular Structure on Burning Velocity. G. J. Gibbs and H. F. Calcote. *J. Chem. Eng. Data 4,* 226 (1959) July (12 pp.)

It is necessary to have a simple reliable method of calculating the burning velocity from the flame dimensions. Although there are a number of methods for determining burning velocities from Bunsen burner flame cones, those which have a reasonable theoretical basis and give reliable results require somewhat detailed measurements or calculations. Article presents a simple procedure which requires a minimum of calculations to obtain reliable results with data demonstrating the errors involved, a comparison with results from other laboratories, and the burning velocities of 77 compounds showing the effect of molecular structure on burning velocity.

Gaslights

Casting Light on Gas Lights. J. Tolman. *Gas Heat and Comfort Cooling 10,* 36 (1959) Sept. (2 pp.)

Question and answer technique is utilized to explain some aspects of the technical side of the industry's newest sales stimulant—the gas light.

Incinerators

Incinerating Organic Waste with No Odors in the Heart of a City. F. M. Reiter. *Ind. Gas* (Amer.) *38,* 10 (1959) Aug. (4 pp.)

Incineration is deemed one of the most satisfactory methods of complete disposal, from considerable bulk to very little clean ash. Combustion temperatures are high enough, combined with ample aeration, to consume vapors and solid particles; to emit colorless and odorless flue gases from the comparatively short stack. Incinerator described had to be installed in the basement of a building where space was limited and valuable, yet it had to have adequate furnace and combustion chamber volume to handle the capacity for which it was rated and installed. Skimpiness would result in incomplete burning of all vapors and particles. Design, within its limited size for this basement location, had to be unusually flexible to take considerable variation in types of refuse fed at different periods.

Performance of a Flue-Fed Incinerator. E. R. Kaiser, J. Halitsky, M. B. Jacobs and L. C. McCabe. *J. Air Pollution Control Assoc. 9,* 85 (1959) Aug. (7 pp.)

Flue-fed incinerator is a convenient means for the disposal and reduction of domestic rubbish and garbage in apartment buildings. Single flue and incinerator serve an entire building. Refuse is charged by the tenants through service doors connecting into the flue at each floor. However, this type of furnace emits particles, unburned gases, smoke and odor to the atmosphere. To overcome this problem, a study of this type of incinerator was conducted. Objective of the program is to improve the combustion in the incinerator furnace in an economical manner. Study is expected to serve as guidance to apartment owners and incinerator constructors, and for the enforcement of air pollution control.

A Study of Effluents from Domestic Gas-Fired Incinerators. G. M. Hein and R. B. Engdahl. (New York: A.G.A., Project No. DG-3M.) June (1959); (27 pp.); $1.50

Measurements were obtained of the effluents from two A.G.A.-developed prototype incinerators, five new manufacturers' units and two representative units of the older type. Two American Standard Association standard test charges that typified wet domestic wastes and dry combustible materials and two special refuse mixtures were burned. Concentrations in ppm by volume in the flue gas, and the emission rates in lb/ton of refuse burned were determined for aldehydes, oxides of nitrogen, organic acids, ammonia and hydrocarbons. Grain loadings and emission rates were determined for particulate matter which included the tarry organic materials. Odor and smoke density also were evaluated. Tabular summaries are presented. Reduced emissions from an A.G.A. prototype and some of the new manufacturers' units compared to the emissions from the older units demonstrates the very significant improvement achieved through recent development of gas-fired incinerators. Improvement also was evident in reduced levels of smoke and odor. Comparison of these emission rates with those from municipal incinerators shows that the new improved gas-fired domestic incinerators have lower particulate emissions and, in general, equally low emissions of gaseous pollutants. Emissions from the improved gas-fired units were in most cases lower than those from other incinerators and large gas- and oil-fired industrial heating units, and were much lower than those from automobile exhaust. Results of study provide a basis for modification of the present restrictions in certain areas on the use of gas-fired domestic incinerators and for confirmation of their present acceptance in other areas.

Industrial Heating

Heat Treatment—A Service by the West Midlands Gas Board. E. Ford. *Gas J. 299,* (Gas in Ind. Sect.) 172 (1959) Aug. 19 (5 pp.)

In the West Midlands area a total load of some 164 million therms of gas/year is consumed by more than 10,000 different industrial users. These consumers represent a cross section of all Britain's leading engineering industries. But the contribution of an area gas board is far wider than the supply of an efficient form of energy for the industrial consumer. In Great Britain, gas boards offer a complete service of advice and research as well as design and manufacture and installation of equipment for specialized applications involving the use of gas. In some cases the industrial workshops of an area gas board will undertake the actual production work on the customer's behalf, for example, where heat treatment or other gas-fired processes are concerned. These facilities are all offered by the industrial department of the West Midlands Gas Board. Article describes facilities, operation and activities carried on in the heat treatment section of the industrial department.

Lost Wax Investment Casting and Other Subjects. J. Ward. *Gas World 150,* (Ind. and Comm. Gas Sect.) 13 (1959) Aug. 15 (5 pp.); **Foundry Processes . . . Ways in Which Gas Can Assist New Techniques.** *Gas J. 299,* (Gas in Ind. Sect.) 176 (1959) Aug. 19 (7 pp.)

Batch firing of molds usually is carried out in natural draft semi-muffle furnaces. These can be hand controlled, automatic temperature controlled or program controlled. On hand control, if the gas is governed down to a low pressure to give a consumption a little higher than the maintenance rate at 1100° C, the furnace will slowly climb up to final temperature over a period of ten hours with its charge. A number of works in Great Britain recently have installed continuous furnaces where continuity of production has been established. In these furnaces the charge end is slowly preheated by the waste gases from the high temperature section and the temperature slowly built up to 600° C prior to the final heating zone. With continuous furnaces, it is essential to insure that the last station maintains the molds at the final firing temperature. Other use for technique are in ladle drying and heating, stress relief annealing, blackheart process and nonferrous foundries.

Water Heaters

Gas Water Heating Equipment. Part 1. Combination Systems. F. Lowe. *Gas Heat and Comfort Cooling 10,* 31 (1959) Sept. (4 pp.)

In the first of a series of articles concerned with all the different types of gas-fired water heating equipment, author deals with the application, economics and servicing of hot water supply from heating boilers.

Air Pollution

Gas Heatng Apparatus. C. T. Hayes (assigned to Oxy-Catalyst, Inc.) U.S. 2,898,201 (1959) Aug. 4.

Small amounts of combustible gases in a gas (oven-vent air) stream are burned to avoid air pollution by improved arrangement of the Houdry type coated-rod catalyst bundles in their path. These gases are mixed with the burning gases of an auxiliary burner, where the original vent gases are preheated by metal-tube heaters which exchange heat with final outlet gas.

Burners

Broiler Burner. E. J. Weber (assigned to A.G.A., Inc.) U.S. 2,896,702 (1959) July 28.

Broiler burner is claimed which comprises a central gas burner head with flame ports directed radially therefrom in a horizontal plane to provide yellow flame radiant heat with the flame protected by stabilizing baffles above and below the plane of the flames.

Gas Fired Burner. J. A. Del Francia. U.S. 2,898,846 (1959) Aug. 11.

Gas-fired cooking broiler is claimed comprising an upright housing support, an insulated firebox containing a burner formed of a horizontal grill of drilled port burner pipes, said burner ports protected by V-shaped grease troughs to protect ports from drippings, and a bed of ceramic "coals" overlying the burner for receiving and radiating the heat upward to cooking grill top. The outer surfaces of the housing are cooled by air rising from below through spaced passages and downward radiation from the burner is offset by horizontal baffles.

Inert Gases

Gas Generator. C. W. Sanzenbacher and J. Huebler (assigned to Surface Combustion Corp.) U.S. 2,897,158 (1959) July 28.

Improved generator is claimed for producing "atmospheric gases" from methane fuel which comprises a vertical refractory combustion chamber, with burner and burner-tunnel entrance firing downward into the top, a granular catalyst bed spaced below the burner to permit empty space for air-gas combustion and a bottom gas outlet leading to a gas cooler. A rich- or lean-gas product is attained by adjustment of air-gas ratio of the feed. By controlled recirculation of cooled product gas to the combustion space, a lean-gas of desired composition is obtained without excessively high temperatures in the generator.

10. EQUIPMENT AND INSTRUMENTATION

Automation

Murton Coking Plant. *Gas J. 299,* 178 (1959) Sept. 2 (9 pp.)

Article stresses great success achieved in applying what might be termed "near automation" to a coking and byproduct plant. At Murton, the conveying of washed slacks from the adjoining colliery's washery, their treatment and subsequent journey to the coke oven storage bunker are, in fact, controlled from a desk in a dust free room underneath the coal blending bunkers. In the coking industry, the effect of heat recovery by a more efficient regenerator system or its conservation by better general insulation of the battery is that more surplus gas becomes available for disposal to the local gas board. At Murton this amounts to about 7.5 MMCF/day. Provision has been made to extend the plant at some future date and additional ovens may be built as a continuation of the present batteries beyond the coal service bunker, which would avoid construction of a second bunker.

Computers

Analog Computers Draw Answers to Questions. P. E. Parisot. *Chem. Eng. 66,* 137 (1959) Sept. 7 (8 pp.)

General purpose analog computer is an electronic device which regulates voltages at various points in its electrical circuitry. When the circuitry represents a physical process, the voltage regulation simulates the fashion in which that physical process regulates its dependent variables. Similarity of behavior of the analog computer voltages and the physical process variables is the analogy. Article includes discussion of components, programming and installation of the general purpose analog computer.

Digital Computers Try Engineering Problems. W. E. Ball. *Chem. Eng. 66,* 129 (1959) Sept. 7 (8 pp.)

Article deals with "stored program" computers, and gives a description of the three computer components (input-output devices, storage devices, and arithmetic and control units), computer language, programming and application.

Gas Turbines

How to Calculate Gas Turbine Exhaust Heat Utilization. C. R. Apitz. *Amer. Gas J. 186,* 29 (1959) Sept. (3 pp.)

Total energy conversion concept made possible by the gas turbine is an important concept. All power cycles are for the conversion of fuel energy to more usable forms. Some cycles produce only shaft power. Gas turbine produces both shaft power and recoverable heat energy, making it the most efficient cycle commercially available to industry. Through the use of properly designed waste heat recovery equipment, savings in fuel are added to the other advantages of lower maintenance and lower operating costs attributed to the gas turbine. To understand how and why this is possible, it is necessary to review the basic gas turbine cycle. Article uses the Clark Model TA turbine as an example. Similar data are available for other turbines upon request from the respective manufacturers.

Jet Engine Invades Gas-Turbine Field. *Oil Gas J. 57,* 99 (1959) Sept. 7; **Jet Power for Pipeline Compressors.** *Petrol. Week 9,* 42 (1959) Sept. 11 (2 pp.); **Aircraft Jet Harnessed to Pump.** *Business Week 1567,* 83 (1959) Sept. 11 (4 pp.)

Modified version of J-57 jet engine is being modified to drive a specially designed gas turbine. Using natural gas as a fuel, the jet-turbine combination will be a natural for gas transmission lines. First model is due for such service next year when a centrifugal compressor will be coupled to the jet-turbine combination for installation on a natural-gas pipeline. Basically as an industrial gas turbine the unit is applicable anywhere industrial power is required, such as refineries and petrochemical plants.

Industrial Heating

Engineering and Economic Elements in the Choice of Industrial Heating Equipment. C. F. Olmstead. *Ind. Heating 26,* 1543 (1959) Aug. (2 pp.)

Suggestions for selecting the most economic and appropriate industrial heating equipment for a particular application are given. Article is a condensation of a paper presented at a symposium on economics and applications of modern industrial heating.

Medium Pressure

Medium Pressure Gas Flow Calculator. J. Nachbar. *Air Conditioning, Heating and Ventilating 56,* 92 (1959) Sept. (2 pp.)

Three-disk calculator has scales developed for gas of specific gravity of .65 (air = 1.00) with multiplying factors for gases of higher or lesser specific gravity. Slide rule is based on gas flow at altitudes of 500 ft above sea level. For all practical purposes, however, calculator will give sufficiently accurate readings at altitudes up to 1,500 ft above sea level, or higher, depending on the required accuracy. Use of the calculator in the range of pressures above 22 psi and for altitudes higher than 1500 ft is de-

scribed. All scales are based on the Weymouth formula for pipes of 3-in. diam and larger, and on the Cox formula for pipes of less than 3-in. diam.

Moisture

Method for Measuring the Moisture Content of Air. J. Higgins. *J. Sci. Instruments 36,* 300 (1959) July (3 pp.)

Water vapor in a sample of air is first condensed as ice and subsequently allowed to evaporate at room temperature, so causing a pressure rise in a closed, evacuated system, the pressure being measured by a simple oil manometer. Apparatus for doing this is described in detail and, by a calibration of the instrument with known masses of water vapor, a factor can be obtained that converts the observed vapor pressure to absolute humidity with an over-all accuracy better than 1%. Apparatus also has been used to study the relationship between water vapor pressure e (mm of mercury) and absolute humidity h_v(g/m^3). A value of 286.4 $\pm$ 1.7 was obtained for the constant C in the equation $h_v = Ce/T$ where T was the absolute temperature (°K).

Piping

Calculating Pipe Stress Efficiently. K. H. Hsiab. *Heating, Piping and Air Conditioning 31,* 106 (1959) Sept. (4 pp.)

In a previous series, author developed a tabular procedure for the efficient and time-saving calculation of forces, moments and stresses due to thermal expansion of piping systems. Procedure is based on the 1955 American Standard Code for Pressure Piping which contains important changes in 1) application of the flexibility factor, K, and the stress intensification factor, i; 2) the formulas and calculation of factors K and i, characteristic factor, h, allowable stress (stress range), maximum expansion, force and moment ranges, and hot and cold reactions; and 3) the phenomenon of self springing. Introduction of the transverse and differential virtual lengths are the major reasons for the time-saving feature of this procedure. In a subsequent series by Wert (see *Gas Abstracts 14,* 263), an algebraic method for hand calculation and a well-organized input data form for computation by the Kellogg method with the IBM 650 electronic digital computer was presented. As an illustration, a two-anchor three-dimensional system was analyzed, using both methods. Wert's example system is analyzed in article by means of the present procedure. Numerical results are found to be in close agreement with his. Thus, the two methods check each other for validity and accuracy.

Shale Oil

Pilot-Plant Operation of Gas-Flow Oil-Shale Retort. V. Kalcevic and J. D. Lankford. *Bur. Mines Rep. Invest. 5507* (Washington: U.S. Dept. of the Interior, 1959) (34 pp.)

Gas flow retort for thermal processing of oil shale to recover shale oil was developed by the Bureau of Mines. Retort is a crossflow gas-to-broken-solids heat exchanger. Heating medium is the gas produced in the shale retorting process. Gas is heated in specially designed stoves outside the retort and recycled to the retort. Oil shale from the Mahogany ledge section of the Green River formation in northwestern Colorado was the material processed. Indicated maximum oil recoveries for 20- to 25-gal/ton shale in a 12-in. thick shale bed and a 20-in. bed are 96 and 91 wt % of Fischer assay, respectively. Heat requirements for maximum recovery are 600-750 Btu/lb of shale. Retort heat transfer mechanism, although continuous, is equivalent to a gas-to-broken-solids batch system. Operation of the retort is hindered by deposition of cokelike material in the retort off-gas system and by stoppage of the shale bed when rich shales assaying over 40 gal/ton are retorted.

Coatings

Pipe Lining Apparatus. A. G. Perkins (assigned to Pipe Linings, Inc.) U.S. 2,897,779 (1959) Aug. 14.

Machine for applying mortar coatings or linings to the inside of pipe is claimed with improved means for maintaining the machine in a desired upright position as it travels through the pipe. Bevelled carriage wheels are used which, with low center of gravity, urge the apparatus carrying the mortar distribution to slide sidewise to the lowest point of inner circumference.

Metering

Fluid Flow Meters. E. E. Turner (assigned to Raytheon Co.) U.S. 2,896,449 (1959) July 28.

Fluid flow meter is claimed which comprises a probe to be inserted into the stream, said probe carrying an electro-acoustic transducer arranged to project a beam of sound energy in a direction parallel to the flow, with a balanced resistance bridge detector to determine resistance to radiation of energy. Such transducers may be used in pairs, radiating in the direction of, and opposed to flow, to amplify the sound energy signal.

Mass Flowmeter. H. L. Mason (assigned to the U.S.A. as represented by the Sec. of Commerce.) U.S. 2,896,450 (1959) July 28.

Flow meter is claimed for mass flow measurements in a conduit which utilizes the Magnus effect. This

consists of a constant-speed rotating cylinder with axes transverse and vertical to the stream, supported elastically by a flexible arm. The force exerted on the cylinder normal to fluid flow causes a flexing of the supporting arm, which is detected by a strain gage or a pressure nozzle proximity gage, calibrated to mass flow.

11. MATERIALS OF CONSTRUCTION, AND CORROSION

Cathodic Protection

Current and Potential Relations for the Cathodic Protection of Steel in a High Resistivity Environment. W. J. Schwerdtfeger. *J. Research, C. Eng. Instrumentation 63C,* 37 (1959) July-Sept. (9 pp.)

In order to evaluate potential and current criteria for the cathodic protection of bare low-carbon steel in a high-resistivity environment, specimens were exposed in the laboratory for a period of two months to a soil having a resistivity of about 20,000 ohm-cm. Previous work by author and others in low-resistivity environments has shown that corrosion can be reduced to a negligible degree by polarizing a steel structure to -0.85 v (protective potential) with reference to a copper-copper sulfate electrode. In such studies by the author, cathodic polarization curves also have been shown to be useful in indicating the current density required for cathodic protection. In the present study, these criteria are again evaluated. In addition to protecting the steel at the protective potential (free of *IR* drop), the effect on protection of including *IR* drop caused by the protective current also was noted. Also, cathodic polarization curves were obtained on a recorder in conjunction with a bridge circuit to eliminate the *IR* drop. Current required for protection was about three times the magnitude of the corrosion current; therefore, the corrosion reaction either was under anodic control (unlike previous studies) or an equivalent type of control which was caused by high resistance at anodic areas.

Coatings

Chemical Engineering Reviews. Protective Coatings. F. Scofield. *Ind. Eng. Chem. 51,* (Part 2) 1213 (1959) Sept. (2 pp.)

During the past year, literature indicates that the principle emphasis has been on the catalyzed coatings and their close relatives—coatings based on epoxy, urethane or unsaturated polyester resins, usually as two-component systems. Wallgreen has reported on the organized research program of the Swedish paint industry on anticorrosive coatings in which the climate, degree of rusting of the steel, pretreatment and other factors are being studied. Gulyaev and Zhdanova recommend a polyisobutylene coating for corrosion resistance. Coating of pipelines continues to develop much interest. The National Association of Corrosion Engineers has developed a tentative specification. Seventy items are included in the bibliography.

Corrosion

The Action of Cathodically Evolved Hydrogen on Iron and Nickel as Special Cases of Corrosion-Embrittlement of Metals. M. Smialowski. *Chem. & Ind.,* 1078 (1959) Aug. 29 (6 pp.)

Objective of study was to elucidate hydrogen embrittlement using electrochemical and metallurgical methods of investigation simultaneously. Article presents only the principal methods, decisive results and general conclusions. Saturation process of metals with cathodically evolved hydrogen proceeds in several stages and has various effects. Soft and ductile materials, such as annealed iron, mild steel and nickel, are first embrittled. In a further stage of hydrogenation there occurs a small but easily measureable expansion of iron and mild steel samples, but with nickel no dimensional changes are observed.

Corrosion of Type 310 Stainless Steel by Synthetic Fuel Oil Ash. H. L. Logan. *Corrosion 15,* 443t (1959) Aug. (4 pp.)

In an investigation of the corrosion of Type 310 stainless steel in synthetic fuel oil ash, the minimum temperatures at which the steel was attacked by a mixture of V_2O_5 and Na_2SO_4 and by mixtures of V_2O_5 and $NaVO_3$ were determined. The minimum temperatures ranged from 1075° F for a mixture of 67% V_2O_5 and 33% $NaVO_3$ to 1220° F for a mixture of 88.5% V_2O_5 and 11.5% $NaVO_3$. An unidentified phase was produced at the interface between the steel and a vanadium compound or mixtures of compounds in the temperature range 1075° F to 1890° F. There was evidence that this phase penetrated into the steel at grain boundaries. Steel heated above 1700° F in contact with a vanadium compound or a mixture of these contained nodules of an unidentified phase at the grain boundaries. Spectrochemical analyses of the slag (fused synthetic mixture) indicated that it contained some of the components of the steel in the same proportions as they were present in the steel.

Factors Influencing Corrosion. G. V. Akimov. *Corrosion 15,* 455t (1959) Sept. (14 pp.)

External and internal factors influencing the rate and distribution of corrosion are discussed. Among the external factors considered are: pH of the solution,

influence of elements acting as inhibitors or as stimulants of corrosion, the concentration of neutral salts, the temperature of solution and the rate of solution movement. Corrosion damage caused by stray electric currents is described in detail and measures eliminating or minimizing their effect are suggested. Internal factors considered include the inherent chemical properties of elements (that is, their position in periodic table). However, a distinction is made between chemical and corrosion stability, because of the possible formation of protective films. Furthermore, the influence of internal stresses as well as of alternating stresses in metals in corrosive media (corrosion fatigue) is described. Surface conditions influencing corrosion are mentioned. Stability of monophasic and heterophasic alloys and the influence of grain size on corrosion are discussed. Finally, experimental data on stability limits of solid solutions and related phenomena such as dezincification are given and some attempts at the explanation of stability limits of solid solutions are mentioned.

Mitigation of Casing Corrosion in Gas Storage Wells. Y. W. Titterington. *Gas Age 124,* 22 (1959) Sept. 3 (8 pp.)

External casing corrosion has proven particularly costly in some gas fields. It is usually associated with a water sand. Occasionally it has resulted in the actual plugging and loss of a well. Some producers, rather than attempt to repair leaks, have established a policy of abandonment and the drilling of a new well at a cost of $30,000-$35,000. Author describes cathodic protection as providing a field-tested solution to corrosion problems in storage wells. Article covers the causes and detection of corrosion, as well as current requirements and application of cathodic protection.

Stress Corrosion Cracking of Oil Country Tubular Goods. R. L. McGlasson and W. D. Greathouse. *Corrosion 15,* 437t (1959) Aug. (6 pp.)

Stress corrosion cracking as encountered in oil production is discussed as two problems: Sulfide corrosion cracking and sweet corrosion cracking. Brief review of the literature is included. A new test method is given which uses a notched ring loaded to different percentages of yield deformation. Also includes simple polished beam specimen test methods. Tabular data are given on hardness, applied stress and time-to-failure obtained in a saturated H_2S-brine system using J-55 and N-80 steels. Concludes that any steel will suffer sulfide corrosion cracking above given hardness limits and that these limits depend on applied stresses. Tests to reproduce failures in sweet systems are reported. Conclusion is drawn that sweet cracking failures are sulfide cracking at low H_2S concentrations and that time-to-failure is an inverse function of the H_2S concentration.

Inhibitors

Screening of Inhibitors to Prevent Chloride Stress Corrosion. J. H. Phillips and W. J. Singley. *Corrosion 15,* 450t (1959) Sept. (5 pp.)

Series of screening tests were conducted in tilting autoclaves to evaluate performance of selected, potential inhibitors in preventing chloride stress corrosion attack of Type 347 austenitic stainless steel in alkaline-phosphate boiler water containing 50 or 500 ppm chloride. From the test results, several inhibitors were tested further to evaluate concentration effects. Nitrate appeared to be a satisfactory inhibitor for boiler applications. Sodium sulfite also effectively prevented chloride corrosion cracking by scavenging oxygen.

Insulation

Cryogenic Insulation. R. H. Kropschot. *ASHRAE J. 1* 48 (1959) Sept. (7 pp.); **Cryogenics: Piping for the Future.** *Heating, Piping & Air Conditioning 31,* 94 (1959) Aug. (2 pp.)

Article discusses the various cryogenic insulation techniques currently being used and provides some examples of their applications. The material is divided into five sections: 1) High vacuum insulation; 2) multiple layer insulation; 3) vacuum powder insulation; 4) rigid foam insulation, and 5) supports. Each section discusses experimental techniques of obtaining insulation data, selected experimental results and apparatus using such insulation. Second article briefly outlines other papers presented at the Conference. Topics range from design of piping systems for transporting liquefied gases at temperatures down to —460° F, to general fundamentals, pump design and application in missiles and space vehicles.

Low Temperature Insulation for a Liquid Methane Pipeline. *Gas Times 98,* 19 (1959) Aug.

Details of the insulated aluminum pipeline constructed at Canvey Island to carry the liquid methane from the Methane Pioneer to storage tanks. Insulation of this unloading line presented several problems. It was considered important, because of the moisture vapor problem, to use an insulating material with as high a resistance to this phenomenon as possible. Expanded ebonite was the material selected. Moisture vapor (at pressure difference of up to 30 mm of Hg) transmission through 1 sq ft of this material 2-in. thick would be 0.069 g/24 hr, and this remarkably low figure, combined with a K factor of 0.20 Btu at a mean temperature of 10° C,

made this ebonite an excellent material for the project. While it did not eliminate the use of a vapor seal, it gave a large measure of resistance in itself.

Metals

Chemical Engineering Reviews. Iron, Carbon Steel and Alloy Steel. R. W. Vanderbeck and E. H. Phelps. *Ind. Eng. Chem. 51,* (Part 2) 1178 (1959) Sept. (7 pp.)

During the period 1956-8, iron and steel industry has witnessed the development of ferrous products with considerably higher strength and better notch toughness than were previously available. Greater strength of tubing, casing and pipe has been instrumental in expanding their usage because of the economies available. Where corrosion is a factor, testing and research have expanded the applications of iron and steel. Resistance of API N-80 steel to sulfide corrosion cracking is improved by a tempering heat treatment at 1100°-1150° F. Experimental steels containing nickel, copper and phosphorous are much more resistant to corrosion than carbon steels in marine applications. References in the bibliography total 127 items.

Plastics

Chemical Engineering Reviews. Plastics. R. B. Seymour. *Ind. Eng. Chem. 51,* (Part 2) 1204 (1959) Sept. (9 pp.)

From the literature it is shown that sales of plastic pipe exceeded $50,000,000 in 1958, over 75% for water supply systems. Sales of $90,000,000 and $250,000,000 are predicted for 1960 and 1966, respectively. Over two-thirds of the thermoplastic pipe used is polyethylene. Acrylonitrile-butadiene styrene and rigid vinyl account for 20 and 10% of the present market. Comprehensive market reports on plastic pipe have been published with statistical data, reports of progress and comparative costs. Sorell has supplied engineering data and information on the advantages of plastic pipe. Bibliography includes 246 citations.

Lightweight Plastics Compete with Metal for Piping, Valve and Fitting Market. R. H. Marks. *Power 103,* 65 (1959) Sept. (6 pp.)

Experts predict that plastic-pipe sales will hit the quarter-billion dollar mark by 1975. Plastic materials readily handle both water and highly corrosive liquids. Cost is low compared to stainless steels and other corrosion-resistant alloys. New plastics hold promise of improved pressure and temperature resistance. Article discusses the technological improvements made in some plastics, describes characteristics of others and deals with cost factors.

12. ANALYTICAL METHODS AND TESTS

Chromatography

Detection of Trace Constituents by Gas Chromatography. Analysis of Polluted Atmosphere. P. S. Farrington, R. L. Pecsok, R. L. Meeker and T. J. Olson. *Anal. Chem. 31,* 1512 (1959) Sept. (5 pp.)

Gas chromatographic technique is described for analysis of polluted atmosphere, determining components present in the range of a few parts per hundred million. Quantitative estimation is made by measuring the area under the chromatographic peak. Method is applicable to a large variety of organic compounds.

Device Aids in Detection of Ethane. A. F. Cascioli. *A.G.A. Monthly 41,* 9 (1959) Sept. (2 pp.)

Separation of the pertinent constituents to be detected, i.e., methane and ethane, was accomplished through gas chromatography by using a 3-ft silica gel column of ¼-in. O.D. and a carrier gas of oxygen or air. As each component came through the column, it was detected and measured by a sensitive catalytic combustion filament and then read on a microammeter in a Wheatstone bridge circuit. After about two minutes, any ethane present passed through the column and the deflection and its magnitude were read from the meter. This deflection was considerably smaller since the ethane concentration in natural gas is only about 1/20 of the methane. When all the ethane had passed through the column, the meter needle returned to zero.

Coal Analysis

Ash Composition of Some British Coals. K. Dixon and L. H. Leighton. *J. Inst. Fuel 32,* 363 (1959) Aug. (7 pp.)

Three sets of data are presented. First refer to a study of day-to-day variability in composition of the ash of five grades of untreated smalls. Second comprises average analyses of the ash of 183 commercial grades of coals produced in the East Midlands Division of the National Coal Board. Third concerns eleven individual seams from six coalfields and is the result of a pilot survey conducted to assess the variability in ash composition of a seam with a colliery take. These data are discussed with particular reference to variability of ash composition. Main conclusions are: 1) In clean coal, localized variations in the amount of pyrites and ankerite in the mineral matter confer a marked degree of variability on the composition of the ash even when the level of ash shows little variation; 2) in high-ash, untreated coals, the effect on ash composition of

variations in the amounts of pyrites and ankerite is considerably damped, but nevertheless the variability of ash composition in these coals is large enough to make an average analysis of a marketed grade—as opposed to analysis of a specific consignment—of limited value in predicting slag characteristics.

Hydrocarbons

Arsenic in Naphthas. G. W. Powers, Jr., R. L. Martin, F. J. Piehl and J. M. Griffin. *Anal. Chem. 31,* 1589 (1959) Sept. (5 pp.)

Chromatographic and colorimetric techniques are combined for the determination of trace amounts of arsenic in naphthas. Arsenic is adsorbed onto silica gel and eluted with acid. It is converted to arsine and reacted with silver diethyldithiocarbamate in pyridine. Adsorbance is measured at 540 mμ.

Determination of Microgram Quantities of Arsenic in Naphthas with Oxyhydrogen Burner. D. K. Albert and L. Granatelli. *Anal. Chem. 31,* 1593 (1959) Sept. (4 pp.)

Arsenic concentration in naphthas at the parts per billion level is quantitatively determined after sample combustion in a Beckman oxyhydrogen burner. The arsenic is dissolved in sodium hydroxide, converted to arsine, and determined spectrophotometrically with silver diethyldithiocarbamate in pyridine.

Infrared Spectroscopy

Continuous Determination of Carbon Monoxide and Hydrocarbons in Air by a Modified Infrared Analyzer. M. B. Jacobs, M. M. Braverman and S. Hochheiser. *J. Air Pollution Control Assoc. 9,* 110 (1959) Aug. (5 pp.)

Estimation of hydrocarbons and carbon monoxide in small amounts in the ambient air has been difficult, but with a suitable modification of the nondispersive type of infrared gas analyzer, continuous analysis in low concentrations has been achieved. By increase of length of the sample tube and by increase of the pressure of sampling of the Lira-type infrared analyzer, the sensitivity of this instrument was increased sufficiently so that it could be used for direct measurement of carbon monoxide in the ranges of 0-20 ppm and 0-50 ppm and of hydrocarbons such as hexane in the ranges of 0-5 ppm and 0-10 ppm. Elimination of the interference of water vapor attributable to its absorption in the infrared by saturating the air stream with water vapor and adjusting the controls has made the instrument suitable for continuous determination of air contaminants in the ppm range.

Mass Spectrometer

High Mass Spectrometry. Propylene Polymer, Alkylated Benzene, and Wax Analysis. R. A. Brown, D. J. Skahan, V. A. Cirillo and F. W. Melpolder. *Anal. Chem. 31,* 1531 (1959) Sept. (8 pp.)

During the past ten years, the high mass spectrometer has assumed an outstanding position for analyzing mixtures of organic compounds having low vapor pressure. Progress is described relating to the improvement of instrumental and operating techniques which provide greater reliability and versatility than previously attainable. Quantitative methods of analysis are presented for propylene polymers, alkylated benzenes, and petroleum waxes. Wax calculation procedure is designed for handling on a digital computer as shown. Calibration data are included which should enable other laboratories to use these methods directly.

Nitrogen

Trace Analysis for Total Nitrogen in Petroleum Fractions. Adsorption-ter Meulen Method. E. C. Schluter, Jr. *Anal. Chem. 31,* 1576 (1959) Sept. (6 pp.)

Trace amounts of organic nitrogen compounds in petroleum fractions poison conversion catalysts. The determination of total nitrogen in petroleum fractions at very low concentrations presents a serious analytical problem. By the method presented in the article the nitrogen compounds are concentrated from a relatively large volume of hydrocarbon by adsorption on a silica gel column. This column then is placed in a ter Meulen apparatus where the nitrogen compounds and the hydrocarbons wetting the gel are desorbed by hydrogen and heat. The vapors pass through the ter Meulen catlyst with very little pyrolysis of hydrocarbons. The nitrogen compounds are converted to ammonia, which is collected in an absorber and determined by standard methods. The procedure may be used to determine as little as 0.1 ppm of nitrogen.

Particle Size

Improved Cascade Impactor for Measuring Aerosol Particle Sizes. R. I. Mitchell and J. M. Pilcher. *Ind. Eng. Chem. 51,* (Part 1) 1039 (1959) Sept. (4 pp.)

Various parameters affect the impaction process in a cascade impactor for determining the particle-size distribution of aerosols and sprays. Studies on the jet-to-slide distance which affects the sharpness of classification, and on wall-to-slide distance which affects the loss of particles on the wall were emphasized particularly. An improved cascade impactor containing round jets and slides was designed and calibrated. Problems encountered in the calibration process were studied and solved. Studies of the wall loss that may be expected for each stage of the impactor were conducted. This improved impactor

and modified versions have been used to determine the particle size distribution of air pollutants, therapeutic and biological aerosols, and cigarette smoke.

Piping

Continuous Fluoroscopic Inspection of Line Pipe. A. B. Wilder and E. B. Henry, Jr. *Pipe Line Ind. 11,* 26 (1959) Aug. (6 pp.)

Fluoroscopic inspection unit, installed in the pipe mill production line between the expander and end facers at National Tube's McKeesport, Pa., plant, has been proving highly efficient in detecting flaws in the longitudinal weld area on line pipe. Unit is the result of experimental work conducted at Battelle Memorial Institute. It processes about 20 joints of 40-ft pipe/hr. Development of commercially available image intensification systems led directly to National Tube's sponsorship of a feasibility study of fluoroscopic pipe inspection. Objectives were: 1) To establish feasibility of fluoroscopy with image intensification as a production inspection tool for large diameter submerged arc welded pipe; 2) to ascertain operating characteristics including sensitivity, speed of operation, most desirable method of image presentation, etc., and 3) to make recommendations as to the type of X-ray and fluoroscopic equipment that would be most suitable, as well as the general characteristics of the pipe handling machinery required.

Sulfur

Separation and Determination of Microgram Amounts of Sulfur. R. P. Larsen, L. E. Ross and N. M. Ingber. *Anal. Chem. 31,* 1596 (1959) Sept. (2 pp.)

Sensitive method is outlined for the determination of micro amounts of sulfur in uranium trioxide, sodium zirconium fluoride, and hydrofluoric acid. Fusion causes the evolution of sulfur trioxide which is reduced to the dioxide and determined with pararosaniline and formaldehyde.

Sulfur Oxides

The Concentration of Sulphur Dioxide in the Atmosphere near Power Stations. W. G. Cummings and M. W. Redfearn. *J. Inst. Fuel 32,* 358 (1959) Aug. (6 pp.)

Central Electricity Research Laboratories portable sulfur dioxide meter has been used to measure the concentration of sulfur dioxide in the atmosphere near eleven power stations with stack heights ranging from 180-450 ft. In all cases the concentration of sulfur dioxide at ground level was low and maximum concentrations did not exceed 30 parts of sulfur dioxide in 100 million parts of air in normal weather.

13. BASIC SCIENCE

Adsorption

Gas Adsorption Chromatography. J. F. Hanlan and M. P. Freeman. *Can J. Chem. 37,* 1575 (1959) Sept. (14 pp.)

It is found that the "retention volume" in gas adsorption chromatography may be identified in a very simple way with the concept of "apparent volume" in the equation of state for high temperature physical adsorption first derived by Halsey *et al.* It is shown that a considerable body of experimental chromatographic data reduces down to the two parameters of the theory in a reasonable way. The single parameter describing temperature dependence is seen to be related simply to the number of carbons in the skeleton for a series of hydrocarbons, while the parameter describing column capacity shows regular, though unanticipated, behavior. This theoretical connection provides a complete link between static measurements and gas adsorption chromatography.

Carbon

Measurement of the Thermal Properties of Carbonaceous Materials. J. D. Batchelor, P. M. Yavorsky and E. Gorin. *J. Chem. Eng. Data 4,* 241 (1959) July (6 pp.)

Thermal data presented are not entirely comparable in terms of materials and temperature ranges. However, they all bear directly on the problem of heat transfer to carbonaceous briquets containing coal, char and pitch. The heat capacity data measured for coal and char may be combined with values in the literature for pitch to provide composite values applicable to briquets. The thermal conductivity data were obtained directly on briquet samples. There is no apparent reason why the heat transfer film coefficient, h, cannot be applied directly to the heating of carbonaceous shapes of low conductivity.

Carbon Dioxide

The Absorption of Carbon Dioxide by a Quiescent Liquid. E. A. Harvey and W. Smith. *Chem. Eng. Sci. 10,* 274 (1959) June (7 pp.)

Interferometric technique is described by which the absorption of carbon dioxide into quiescent water has been examined. There is no measurable resistance at the interface to solution of the gas into pure water, the rate of absorption into the liquid being governed by molecular diffusion. A measurable interfacial resistance is found when carbon dioxide is absorbed by solutions of surface-active agents.

Thermodynamic Data for Carbon Dioxide at High Pressure and Temperature. P. E. Liley. *J. Chem. Eng. Data 4,* 238 (1959) July (4 pp.)

During a research program conducted to investigate the thermodynamic properties of certain mixtures containing carbon dioxide as one component, it was discovered that very few data for pure carbon dioxide were available at temperatures above 150° C. (Table of recent work on the thermodynamic properties of this vapor is included.) At the period of compilation of these data, only two sources of information for temperatures above 150° C were available, one of which was an experimental investigation to 50-atm pressure from which thermodynamic functions were computed using the same basic spectroscopic data as those used by the National Bureau of Standards. It was decided therefore to tabulate values at much closer temperature and pressure intervals than the data then available, and to extend the tabulation to 200-atm pressure. Article describes the resulting work.

Catalysis

Chemical Reactions Catalysed on a Tube Wall. S. Katz. *Chem. Eng. Sci. 10,* 202 (1959) June (10 pp.)

Progress of a reaction catalyzed on a tube wall is analyzed for an assigned radial pattern of axial velocity. A procedure is given for mathematically transforming an observed axial profile of cross section average reactant concentrations into a plot of the instantaneous reaction rate vs the wall concentration at which the reaction is proceeding. It also is shown how to calculate the average conversion at any contact time for an arbitrary reaction rate function.

Fluid Flow

The ABC's of the Jet Mechanism. L. A. Madonna. *Can. Chem. Processing 43,* 73 (1959) Aug. (4 pp.)

Expert in jet mechanism presents broad outline of the theory of jets and relation to fluid flow and includes references for those who are interested in more detailed studies.

How to Analyze Two-Phase Flow. J. Coates and B. S. Pressburg. *Chem. Eng. 66,* 153 (1959) Sept. 7 (3 pp.)

Ultimately, research being carried out at the present time should put quantitative treatment of multiphase flow on as firm a basis as single-phase flow. In the meantime, each type of multiphase system such as liquid-gas, liquid-liquid or solid-gas is considered separately. For multiphase flow, the most workable methods now available are those for liquid-gas systems. These are based on the work of Lockhart, Martinelli, and their coworkers. These investigators correlate empirical data graphically by making use of two dimensionless ratios, dependent on pressure drops of each phase and pressure drop ratios. Through further evaluation from Poiseuille's law on Fanning's equation, these can be related to weight rates of flow of phases and on ratios of viscosity and density.

Kinetic Theory of the Flow of a Gas through a Cylindrical Tube. O. Gherman. *Soviet Phys.-JETP 7,* 1016 (1958) Dec. (4 pp.); Trans. of *Zh. Eksp. Theor. Fiz. 34,* 1470 (1958) June (5 pp.) by Amer. Inst. Phys., Inc., New York. (From *Appl. Mech. Rev. 12,* 635 (1959) Sept.)

Purpose of paper is to present an empirical interpolation between Knudsen's free molecule results and Hagen-Poiseuille flow. Interpolation formula is developed by assuming that the number density is the sum of two terms: The classical isotropic part and an anisotropic correction term. The correction term is so chosen that it is largest near the center of the tube and is zero at the wall. This is equivalent to assuming that only diffuse reflection is allowed at the walls. It is also assumed that the anisotropic part of the number distribution contributes most strongly in the flow direction, and correctly vanishes as the mean free path increases without limit. While the calculated values based upon the suggested interpolation are in better agreement with experiment than the earlier results, there seems to be much work that could be done along these lines. The significant contribution is the attempt to allow for the presence of the walls, without using the full Maxwell-Boltzmann equation. E. E. Covert, USA

For Laminar Pipeline Flow of Bingham Plastics Use Chart to Find Friction Factors. G. W. Govier. *Chem. Eng. 66,* 139 (1959) Aug. 24 (3 pp.)

By accepting the definition of the conventional Fanning friction factor as being applicable to the flow of Bingham plastics, Govier and Winning demonstrated that the friction factor, f, could be expressed in terms of a modified Reynolds number, R_m, and a yield number, Y. Chart is included to demonstrate method.

Liquid Flow in Ring Packed Beds. The Distribution of Liquid Flow Between the Interior and Exterior of Random Packed Raschig Ring Packings. D. Greenaway. *Chem. Eng. Sci. 10,* 197 (1959) June (6 pp.)

Investigations on water flow in Raschig ring packings were carried out employing columns constructed of wire gauze to minimize wall effects. A study of the mean flow through the ring interiors revealed that this decreased from 29-12% of the total flow as the packing size increased from ½- to 1¼-in. Examination of cross sections cut through a model of a ring packed bed suggested a cause of the observed variation.

Heat Transfer

Determining Maximum Heat Load in Equipment Design. W. R. Deason, W. E. Koerner and R. H. Munch. *Ind. Eng. Chem. 51,* (Part 1) 997 (1959) Sept. (8 pp.)

Heat removal capacity is often a limiting factor in the safe operation of large-scale equipment when exothermic decomposition reactions are encountered. To avoid uncontrollable temperature rise with its attendant hazards of fire and explosion, the maximum rate of heat evolution must be matched by an equal heat-removal capacity. A simple differential thermal analysis method has been developed for measuring rates of heat evolution from small samples, which gives data that can be used readily in the design of large-scale equipment. The apparatus is standardized electrically.

Hydrogen

Thermal Conductivity of Equilibrated Mixtures of H_2, D_2 and HD. C. C. Minter and S. Schuldiner. *J. Chem. Eng. Data 4,* 223 (1959) July (4 pp.)

Question of whether equilibrium is attained in the exchange reaction $H_2 + D_2 \rightleftarrows 2HD$ in a given mixture of electrolytically produced hydrogen and deuterium could perhaps be decided by measuring the thermal conductivity of mixtures of hydrogen and deuterium before and after equilibrating over a nickel catalyst. The experimentally determined thermal conductivities could then be compared with the conductivities calculated on the assumption that equilibrium is attained. In the work reported the thermal conductivity for binary and ternary mixtures of H_2, D_2 and HD must be calculated. The relations developed are ideal in that they involve only the thermal conductivities of the components and their concentrations. Theoretical approximation equations are not calculated for mixtures already in the literature.

Methane

The Interaction of Methane and Nickel Oxide. S. Bransom and A. Dandy. *Trans. Faraday Soc. 55,* 1195 (1959) July (5 pp.)

NiO and NiO containing 1 mole% of Li^+ and Cr^{3+} ions were found to be inert towards CH_4 at temperatures below 400° C when the oxides had been annealed in oxygen. After partial reduction with CH_4 at *t* 400° C the oxides were active from 200°-450° C. Methane was adsorbed to a small extent on NiO and NiO—Cr_2O_3 at 200°-300° C and to a relatively large extent on NiO—Li_2O. Maximum adsorption was observed at *ca.* 250° C and the adsorption NiO—Li_2O was reversible. The capacity of each oxide to absorb CH_4 decreased with progressive reduction of the oxide and finally disappeared. The activity of the reduction-reaction leading to CO_2 and H_2O increased with reduction of the NiO to a reproducible maximum. It was shown that the addition of CO to the gas phase inhibits the reduction-reaction and the deceleration of the reaction with CH_4 is attributed to the accumulation during the reaction of irreversibly adsorbed CO.

Phase Equilibria

Partial Volumetric Behavior in Hydrocarbon Systems. Methane-Cyclohexane System in the Liquid Phase. V. Berry and B. H. Sage. *J. Chem. Eng. Data 4,* 204 (1959) July (7 pp.)

As part of a study of the transport of methane in the liquid phase of the methane-cyclohexane system, measurements of the volumetric behavior of four mixtures of methane and cyclohexane were obtained. In addition, adequate volumetric data concerning the behavior of methane and of cyclohexane were available. These measurements were used as the basis for the evaluation of the partial volumetric behavior of methane and cyclohexane in the liquid phase of the methane-cyclohexane system.

Phase Relations of Gas-Condensate Fluids. C. K. Eilerts et al. *U.S. Bur. Mines,* Monograph 10, Vol. II. (547 pp.) (New York: A.G.A., 1959), $15.00.

Correlations are presented in this volume for computing phase diagrams of gas-condensate fluids from test results measured in the field. These 24 correlations from tests and the literature are designed to aid in solving problems in the recovery of natural hydrocarbon fluids by providing means for calculating compressibility factors and phase-diagram pressures and temperatures of particular fluids. The existing field data required an increase in variety and complexity in order to attain accuracy and wider application of the correlations. Thus pressure liquid-gas ratio, condensate composition and fluid composition measured by field separator, stock tank, routine distillation and low temperature distillation are correlated singly or in combination in four primary correlations to determine phase diagrams for temperatures from 70°-280°F and pressures up to 7500 psia. Techniques of computation and applications of diagrams are discussed. Three main correlations of the compressibility factor are presented, based upon data from specific gravity, composition and minimum compressibility factor. Appendices of pertinent critical and physical constants and details of equipment of the mobile test laboratory are included.

Vapor-Liquid Equilibria. The System Methane-Propane-*n*-Butane at 100° F. T. J. Rigas, D. F. Mason and G. Thodos. *J. Chem. Eng. Data 4,* 201 (1959) July (4 pp.)

Phase behavior for the ternary system methane-propane-*n*-butane at 100° F has been investigated with the equipment tested on the methane-*n*-butane system at 100° F. The cell includes a movable piston, hydraulically activated, which varies the volume of the equilibrium chamber and, consequently, the pressure of the system. Small samples of the coexisting vapor and liquid phases are withdrawn and subsequently are analyzed by means of a mass spectrometer.

Solubility

Solubility of Propylene in Water. A. Azarnoosh and J. J. McKetta. *J. Chem. Eng. Data 4,* 211 (1959) July (2 pp.)

Although a considerable amount of work has been published on the high pressure solubility of the permanent gases, such as hydrogen and nitrogen as well as some of the light hydrocarbon gases, very little information has been published on the solubility of the unsaturated hydrocarbons over any wide pressure and temperature range. Data were obtained in the investigation reported on the solubility of propylene in water at temperatures from 70°-220° F and pressures ranging from atmosphere to 500 psia.

Thermodynamics

Aerothermodynamic and Electrical Properties of Some Gas Mixtures to Mach 20. W. Chinitz, C. L. Eisen and R. A. Gross. *ARS J. 29,* 573 (1959) Aug. (7 pp.)

Pressure, temperature, chemical composition and electrical conductivity data are presented for gas mixtures behind strong air shocks and detonations of hydrogen-air and acetylene-air mixtures up to Mach 20. A digital computer program has been developed which solves the simultaneous aerodynamic and chemical equilibrium equations. The latest thermodynamic and collision cross section data are used. Data also are presented wherein the initial gas composition was varied to obtain the maximum electrical conductivity for a given shock or detonation strength.

Viscosity

Viscosity of Nitrogen, Methane, Ethane and Propane at Elevated Temperature and Pressure. J. D. Baron, J. G. Roof and F. W. Wells. *J. Chem. Eng. Data 4,* 283 (1959) July (6 pp.)

Numerous determinations of the viscosity of fluids at either elevated temperature or elevated pressure are reported in the literature. However, measurements at both elevated temperature and pressure are scarce and have occasionally been obtained by techniques that cannot be considered quantitative. In the investigation reported quantitative measurements were performed on the coefficient of viscosity of nitrogen and the three lowest paraffins over a range of conditions significant for theories of dense gases and of practical importance in the petroleum industry. The nitrogen data provide a comparison with what is considered the most reliable information on the viscosity of a compressed gas at elevated temperature.

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